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ORIGINAL ARTICLES

MUSCLE TRAINING AND ITS RELATION TO ORTHODONTIA*

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WHEN the Chairman of the Board of Censors invited me to read a paper before this meeting, I suggested the title which appears upon the program; but by the time I secured the leisure to collect my material, it became quite evident to me that what I really wished to say to you at this time could better be said under the title, "Muscle Training and Its Relation to Orthodontia." I, therefore, ask indulgence while I proceed to discuss certain questions of vital importance to the profession—questions which are of more immediate practical nature than could be dealt with under the title upon the program.

It is often said that we, in our human experience, learn more from and accomplish more by the study of our failures than by the contemplation of our successes. More or less frequently there occur in the practice of each of us failures to maintain the results of our conscientious efforts. It is true that some of our failures are due to causes which are, at the present time, quite beyond our control. We have many types of children to deal with—children of varying degrees of mentality, health and discipline. It is quite impossible with some children to obtain results where the elements contributive to failure are due to some mental defect making our efforts for that particular individual quite useless. In contemplating certain types of failures in my own practice, I have been reminded that a closer study of those forces of occlusion which could be placed under our immediate control might form a basis upon which to secure more permanent and satisfactory results. It is true that our teachers have been diligent in the past in calling our attention to the various natural forces that contribute to the establishment and maintenance of the occlusion of

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the teeth. Doctor E. H. Angle, Doctor Martin Dewey, and others, have written upon this subject, reminding us of the importance of the various natural forces, such as cell metabolism, forces of the inclined planes, normal approximal contacts, harmony of shape and sizes of the dental arches, atmospheric pressure, and muscular pressure. Those elements which have received the greatest share of our practical attention have been the mechanical forces of the inclined planes and the size and shape of the arches. There is one force, however, a thorough comprehension of the importance of which, it seems to me, has failed to penetrate the mind of the orthodontist in general, although it has been often written about. We have been told how occlusal force and muscular pressure aid the teeth in taking very nearly their proper positions in regard to their buccal and lingual relations, and that normal muscular pressure upon the anterior teeth tends to hold them in their normal relation; yet we have found that in many cases where malocclusions have been corrected, where inclined planes, points of contact, and arch forms have been successfully established, the unbalanced muscular forces have still left our cases in a state of semitreatment.

It is interesting to read from Doctor Angle's observations regarding muscular behavior contained in the second chapter of the seventh edition of "Malocclusion of the Teeth", where he says:

"The influence of the lips in modifying the form of the dental arches is an interesting study, and almost every case of malocclusion offers some noticeable and varying manifestation of it."

In speaking of the upper and lower lips, he further says:

"This force is exerted automatically in response to almost every emotion, and results in maintaining the teeth in harmony with the graceful and beautiful curve of the normal individual arch. In cases of malocclusion, strikingly characteristic abnormalities in lip function are often noticeable, leading to the suspicion that more often than is recognized the peculiarities of the lip function may have been the cause of forcing the teeth into the malpositions they occupy."

It avails us little if we diligently seek to place one part of the human machine in harmonious relation, and neglect that other part upon which permanent success depends. As I have already intimated, our teachers have recognized the importance of muscular pressure in its normal conduct as well as in its abnormal conduct, but here they seem to have stopped, assuming that with the correction of the faulty osseous formation and cusp relation, nature, somehow or other, would establish the correct muscular tone and muscular habits. All of us can recall cases which failed after an unduly prolonged retention—cases of every class and description. It was because of the recognition of these elements that in 1906, in a paper on "The Correction of Facial Inharmonies," read before the Northeastern Dental Association, I was led to say:

"The logical solution of our difficulties, from nature's standpoint, would consist in inducing every organ to perform the normal degree of functional activity. Would that children lived in a normal and healthy environment, for then, slowly but surely, facial inharmonies and malocclusion would become less and less prevalent.

"We must likewise resort to artificial means in order to stimulate those

organs which, having been allowed to degenerate, have failed to perform their natural functions. We must bring into normal position malposed teeth, harmonize the distorted arches, and restore the facial lines to their original grace and beauty."

We know that health means harmony of functional adjustment. If disharmony of function reigns in any part of the organism, it means that some form of interference has influenced the harmonious activity of the affected organ. The psychotherapist in his study of the maladjustment of the nervous system seeks to find those elements of interference which tend to unstabilize the normal functional activity of that system. He recognizes that the nervous system is most delicately balanced and in some individuals the merest suggestion of interference may cause the gravest symptoms of disorder. What is true in relation to the psychotherapist in his investigations will be found true in the experiences of all men, no matter what part of the human organism they have chosen to place under their particular guardianship. If the orthodontist stops to think, he can not but come to a sense of realization that all mechanical and muscular adjustments from the grossest to the more delicate are subjected to disharmonizing influence by myriads of forms of interference whose existence it is his business and duty to investigate. His work should carry him into sympathetic touch with not only the general physician and rhinologist, but with the psychotherapist, the orthopedic surgeon or medical gymnast. In fact, he must have a sympathetic and an open mind toward all sciences which attempt to harmonize the functional activities of the human body. To enumerate the various forms of interference which are especially significant regarding our work, would, I think, take too long for the time at my disposal, but briefly speaking, we have the mental interference, evidence of which is seen in various muscular and nervous habits—the respiratory interference, which may be a factor in insufficient bone growth; then we have postural interferences, which throw the organism more or less completely out of mechanical adjustment; the interference in cusp relation, which reacts upon the guiding and developing muscles of the face. When these influences have been grouped, we are interested to observe how they react upon one another, tending always toward further disharmonious action and the final breaking down of the health of the organism.

I have found, as you all have, that the muscular tissues of the face, where they have once acquired the habit of bad behavior, do not readily assume the normal. That some form of training was necessary became very apparent, and with this conviction solidly established, I proceeded to formulate and practice definite forms of muscle culture for the facial muscles. I soon found that in order to be successful in this branch of the work, it was necessary to make careful study of the various adjustments of the muscle groups, and that in order to obtain proper muscular control, we must also seek to obtain satisfactory mental control. Also, that it is necessary, at the outset, in order to obtain results, that the parent and the child be convinced of the importance of the work and be given their part in the responsibility for future success or failure.

In some forms of malocclusion, the unfavorable position in which muscles appeared to be placed to perform that particular work which they were sup-

posed to do was apparent, and I became strongly convinced that these intricate muscles must be carefully trained in order to assume the exquisite positions in which their normal actions would place them. I soon discovered that ordinary muscle culture would not bring the desired results as quickly or as permanently as a thorough practice of conscious control over the facial muscles. The object of my efforts has been to teach those patients in need of this form of treatment to consciously use the muscles and forces of occlusion, after first being instructed as to their proper positions.

This muscular work, of course, must go along hand in hand with the mechanical treatment of the case, and no undue muscular pressure must be allowed until the patient has learned to place the arches in their proper relation, which function is taught them after the major interferences have been removed. The object of the work is to so strengthen the muscles of mastication that they will assume their normal function not only resulting in a maintenance of occlusion, but in building a stronger masticatory apparatus as well—that the so-called muscles of expression shall be so trained as to be under conscious control, and not allowed to "run riot in response to almost every emotion."

It can be readily understood, then, that we are justified in concluding that our work will be even more enhanced if we are able to obtain the harmonious development of the entire organism. We have accustomed ourselves to think so exclusively of the region of our special effort, that we fail many times to realize that nature works as a whole, and, in order to eradicate any special difficulty, it will be well if, in the young, we can obtain a correct mechanical advantage in all parts of the organism. In order to obtain these great advantages, we must begin at once to consider the value of conscious control in its relation to our work.

It will be essential for the orthodontist of the future to add the science of kinesiology to his course of studies. This science deals with the study of muscular movement, and includes consideration of muscular exercises of all kinds —the reasons why they are performed, their correct performance, and their reactions. He will learn from this study much that will be of value to him regarding various defects and their cures. In the future, I believe, the student of orthodontia will be called upon to make analysis of complex muscular movements, noting carefully the muscles that are involved, and the scope of their influence, applying this knowledge to the muscles of the face. He will soon learn that the work accomplished by the muscles reacts again upon these muscles, developing them and establishing a greater efficiency in action. He will learn that the reactions are not only developmental, but that they are also mechanical by the influence and the relationship which exists between the joints and the shapes of the bones themselves. The orthodontist, then, in order to become completely efficient, will need to understand muscles in their various conditions, and will need, during his treatment of a given case, to have their intricate influences constantly before him. His study of anatomy, myology and physiology, will take on a new interest, because he will have a definite, well-defined reason for understanding the muscles and their function. Giving attention to this subject, it will soon be discovered that the abil-

ity to analyze and solve the various problems of muscular action will not be so easy, because there is an infinite variety of movements and change in form, all of which have their influence in young childhood when they play over and upon the delicate osseous development of the tissues of the face.

The study of this subject is fascinating, because of the intricate and exquisite adjustment which may be discovered. In this relation, I would like to call the attention of my hearers to the danger of misapprehending the essence of scientific muscle culture. I was reminded of this at a meeting at which I read a paper upon this subject. An orthodontist present remarked in the discussion that the act of chewing gum seemed to him in line with the work which I was advocating regarding muscle culture. I should dislike very much to have this empirical view of such important work become prevalent, for the reason, first, that the act of chewing gum for the development of the uncultured muscles is essentially nonscientific, and may be productive of much harm. Somewhere it has been written and emphasized that when inclined planes have assumed an unnatural position, the more they are used, the more severe the malocclusion is apt to become. This is because they are in a position of mechanical disadvantage. To thoughtlessly prescribe a course of gum-chewing to a little patient suffering from a developing Class II, would indeed be poor professional advice. It would be equally disastrous if a patient suffering from a developing Class III, or even a Class I, were to be subjected to an undue amount of muscle tension, with its malinfluence upon the mechanical disadvantage exemplified by the maloccluding planes. After the arches have been developed and the patient has acquired the ability to place the arches and inclined planes in proper relation with one another, a gum-chewing prescription might have some excuse for existence, but even then it is of doubtful value. We are not quite sure that it is a good thing for the digestive apparatus to be subjected to an increased flow of saliva when the natural functions of the alimentary canal do not at that time call for this flow. Nor are we sure that the salivary glands would take kindly to a prolonged course of this kind of treatment and submit gracefully to an overstimulation of their function. It is, moreover, true that the child is apt to develop one side of the mouth much more than the opposite side. Again, it becomes a subconscious habit and loses that particular value which is to be derived by the conscious control resulting in a harmonious unification in the development of all the muscles involved.

In our instructions to patients, it is much better for us to strive to direct the patient to comprehend the control and coordination of his muscles through conscious, well-directed efforts, than to allow him to automatically perform certain prescribed exercises. This mental and muscle training will not only have a beneficial effect upon those parts about which we are directly concerned, but will be of immense value to him in other important acts of his life. Therefore, before the child is allowed to undertake any form of physical work, he must be brought to a realization of the need and importance of such endeavor. The orthodontist in his contact with his patient must discover for him the defects exemplified by the misuse of the various muscle groups. When this has been accomplished, he should then undertake to teach the patient how to inhibit those

sensations which induce him to an imperfect use of his muscular mechanism. He must be taught to understand the imperfect mechanical relations which exist, and must be given also to understand correctly the positions of mechanical advantage; and then, by supplying him with new and correct guiding impulses, he will acquire, in time, the ability to bring about the proper use of his muscular mechanism.

Having then before us the principles of procedure, we are prepared to consider their practical application. The principles are: *First, the mechanical re-establishment of arch form and cusp relation by the simplest mechanical means, thus removing any interference which tends to discourage the normal functions of the muscles. Second, the principle of muscular balance and mechanical advantage in the complete organism, including special guidance and control of those muscles concerned in the particular weakness upon which our attention is to be directed, urging them on to their normal development and strength until the harmoniously developed face completes the restoration of the organism to its normal inheritance.*

We can readily understand that the motor efficiency of the parts of the body upon which we are directing our attention depends upon the ability of our patient to gradually attain the faculty of directing mental stimuli in sufficient amounts to effect their development. It is because of the law of mental growth, known as repetition, that the orthodontist realizes his greatest encouragement regarding this phase of his work, because the things that are done from choice tend to become spontaneous, if often repeated. Therefore, the ability of the muscles to continue the performance of their full functions after repeated efforts of the will, is assured by the educated state of both mind and muscle.

With these ideas firmly established in our minds, we can now proceed to consider and illustrate briefly the practical means by which these changes are brought about.

Fig. 1 represents what we are pleased to accept as the standard—the anatomic section of which gives us a comprehensive view of the area over which certain groups of muscles exert their influence. It is a principle in the procedure of treatment through the stimulation of natural function to rid this space as completely as possible of any apparatus which has a tendency to interfere with the normal action or conscious guidance of the lip and cheek muscles.

It is unfortunately true that in many growing cases it is absolutely essential to our ultimate success that we make use of certain forms of mechanical apparatus; but it is essential to so design them that they will interfere the least with the normal muscular activity.

Textbooks on orthodontia frequently show illustrations of appliances filling the buccal and lingual spaces. The use of these appliances would not be compatible with the simultaneous encouragement of functional activity of the soft tissue. It would be difficult under such circumstances to train the muscles to a free and unhampered action. In most cases I have found the use of the lingual wire (Fig. 2) to be more nearly in accord with the principles we are considering. In younger cases, where the deciduous teeth are still present, the junior

pin and tube appliance (Fig. 3) is sometimes made use of during the early stages of treatment, being removed after a sufficient development has been obtained to allow a free eruption of the teeth—the lingual wire being used on the lower to secure the arch development while the muscles of mastication and expression are being trained to their normal activity. The next (Fig. 4) illustrates the advantage to be gained by the use of the lingual wire.

"The most valuable appliances are those which interfere least with the normal tendencies of development, and in their construction and adaptation are freest from interference with muscular activities and habit-forming possibilities. When it is found necessary to interfere with any normal function whether it be of the tongue, lips or cheeks, some form of compensation must be

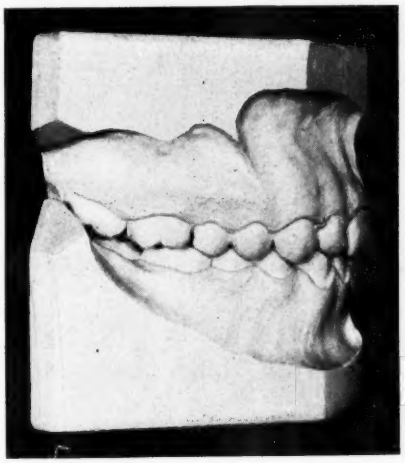

Fig. 1.

Fig. 2.

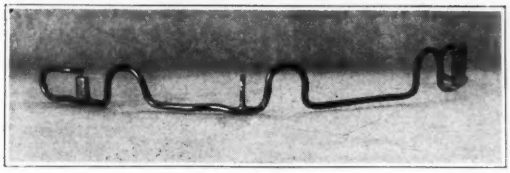

Fig. 3.

provided. Possibly an illustration here will help us to grasp my meaning to better purpose.

The drawing represented in Fig. 5 indicates the direction of the movement for each of the three appliances: labial wire, pin and tube, and lingual wire. It will be seen that with the use of the lingual wire there is greater opportunity for muscular influence in its relation to the individual tooth movement. The expansion arch which for so long a time was our mainstay is, in my opinion, in the light of recent years of experience, a more or less troublesome appliance; especially in regard to its effect upon the normal action of the lips and cheeks, and most noticeably so when it is poorly adjusted, as is often the case. It will be seen that this application, even when neatly accomplished, interferes and forms a barrier between the lips, cheeks and teeth so that their normal function is seriously interrupted. On the other

hand, the lingual wire can be neatly placed where it gives the minimum interference to muscular action. (Fig. 6.)

Briefly then, we have considered the advisability of the simplicity of mechanical interference, paving the way in seeking the greatest advantage to be derived from the stimulation of muscular activity. It will be logical now for us to proceed to a consideration of the various muscle groups and the methods best adapted for their proper development.

The orthodontist among his recollections of failures has a keen sense of the presence among that ghostly group of various forms of Class II which have failed of retention after his prolonged and conscientious efforts with inter-

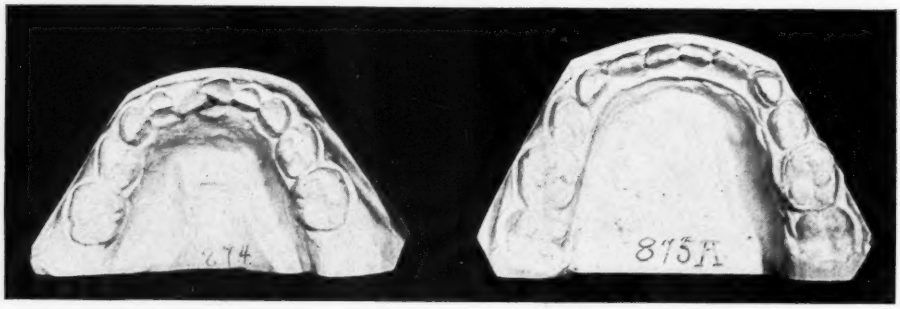

Fig. 4.

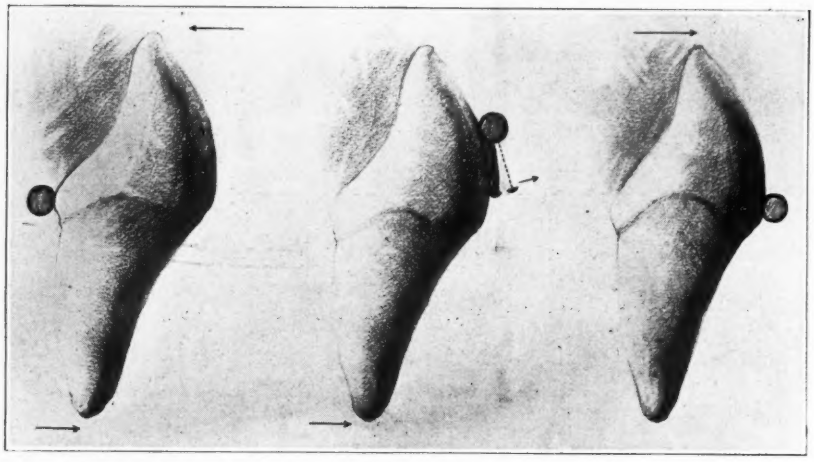

Fig. 5.

maxillary elastics and various forms of retention. Doctor Angle, in his seventh edition, writing of a case treated without intermaxillary elastics, speaks as follows:

"About three years after the discontinuance of retention, on examining the facial lines and the teeth of the patient, an important discovery was made, namely, that although the normal relations had been maintained between the teeth, the mandible had slowly drifted back to probably very nearly its former relations with the skull, but in so doing, the crowns of the teeth of the upper arch had been dragged distally to a noticeable degree, while the crowns of the teeth of the lower arch had been tipped forward. In other words, there

had been accomplished by the muscles of mastication and persistent, difficult retention, what we now aim to accomplish and do accomplish with the Baker anchorage, often in so short a time as three weeks in patients of this age."

Failures of this nature would be much less common with us if the orthodontist understood and applied the principle of conscious control of the muscles of mastication, training them and causing them to do the greatest activity in their normal position. The evident failure in this case was due to an abnormal action of the muscles of mastication, which might have been corrected had the proper attention been given them. It is interesting for us to note at this point in the discussion what Herbert Spencer has to say regarding situations of this nature, taken in a broad sense. He writes:

"Each faculty acquires fitness for its function by performing its function; and if its function is performed for it by a substituted agency, none of the required adjustment of nature takes place, but the nature becomes deformed to fit the artificial arrangement instead of the natural arrangements."

Frequently by the use of intermaxillary elastics, arches are more or less

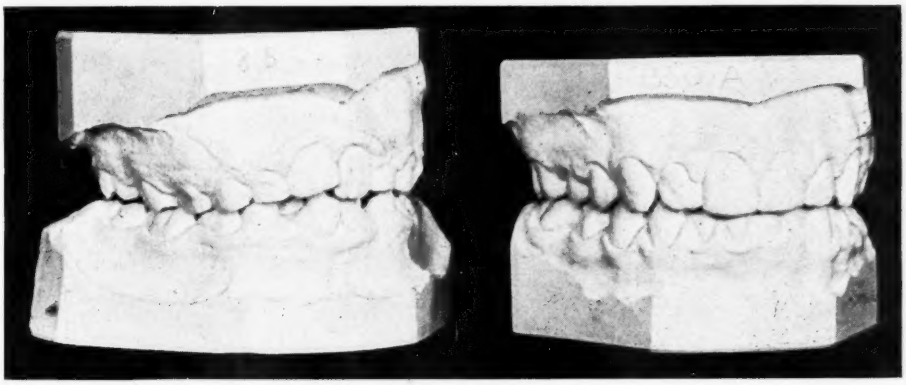

Fig. 6

misshapen on account of the unusual strain brought about by the extreme force which is required if the intermaxillary elastics are to overcome the triple resistance of mind, muscle and malposed teeth.

The patient may in the early stages of treatment in these cases be trained to overcome the handicap by applying proper mental stimuli; and when the time appears when proper adjustment of the mandible with the rest of the skull is possible, the adjustment takes place quite normally and then, if it is supplemented by the strengthening of the masseter and temporal muscles, results are permanent and more beautiful because of the harmonious development and action. In contemplating work of this nature, the orthodontist must ever bear in mind the fact that muscles tend to stay in the position in which they do their most and hardest work, and that this work must be done with the arches in their true relation one to the other, for it is then that the masticatory apparatus has assumed the position of mechanical advantage, and it will be surprising how quickly the various muscle groups will respond to the work thus placed upon them, because they are in the position which nature has intended that they should occupy.

It will be logical for us at this point to direct our attention to that most important group of muscles—the external and internal pterygoids. The advantageous positions which Nature has given these groups will be readily seen. They are the muscles which control the movements of the mandible. During early life they are readily controlled, which accounts largely for the fact that they often give way to the suggestions furnished them by slight interferences incident upon the narrowing of the upper arch and by the interference of the upper lateral incisors in lingual occlusion. If the mandible is forced into distal position, these muscles soon form the habit of keeping it there. It may be well for me at this point to emphasize the importance of the early exercise of these muscles in cases where it is required. This is true even where

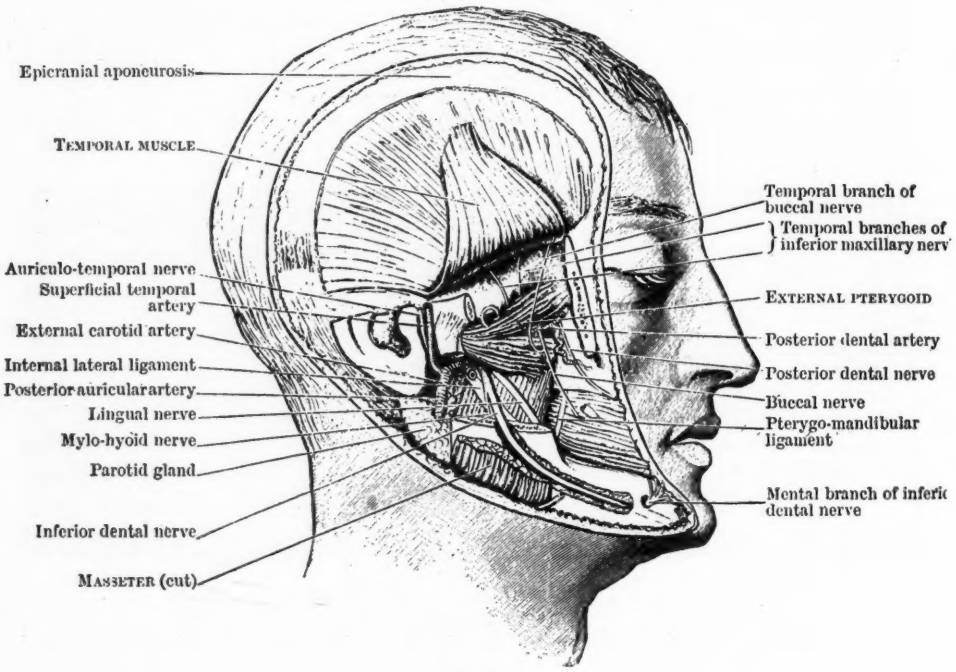

Fig. 7.

intermaxillary elastics are proposed, or where inclined planes upon the anterior teeth are contemplated. (Fig. 7.)

Particularly is this necessary when we contemplate the changes that take place in the glenoid fossa as the child grows to maturity. You have all experienced, in treating younger cases, the voluntary shifting of the mandible upon the removal of the interference frequently caused by an abnormal narrow upper arch, or perhaps the interference of upper lateral incisors in lingual position. The voluntary change does not take place so readily in older children, for the reason that the glenoid fossa has become of such shape as to discourage the pterygoid muscles in overcoming the handicap. It is good practice in cases of Class II to train these muscles through exercise, so that the proper position of the mandible is readily taken when opportunity is given to it. It not only relieves strain upon the teeth, but avoids many other complications. Of course, there are cases in which light intermaxillary elastics will be found of

advantage. In changing our methods of practice, it is not always wise to jump abruptly from one idea to another until we have made so sure of our footing that there is little danger of failure. When intermaxillary elastics are to be used, it seems to me that the operator should study to make his use of them as light and their period of use as short as possible. The exercise of the pterygoid muscles previous to the application of inclined planes on the anterior teeth I have found of great service, as the mandible may be readily trained to take the forward position, avoiding greatly the strain which is usually heaped upon the incisors, if this form of apparatus is placed upon them without taking this precaution. Viewing these illustrations, and reviewing the possibilities consequent upon the control of these muscles, it will, it seems to me, be logical for us to regard them as intermaxillary elastics of nature. And I believe you will agree with me that when they have been trained

Fig. 8.

to perform their functions accurately and well, they may be depended upon to furnish us a guarantee of unusual merit for the permanence of our treatment. The exercise of these muscles consists in throwing the mandible forward, as shown in Fig. 8. The patient requiring this form of exercise is instructed to throw the mandible forward as far as possible, or until the lower anterior teeth are placed in labial occlusion to the uppers, and held there for ten or more seconds and then slightly relaxed. The effort is then repeated as many times as the nature of the case requires. In some cases this will at first be found impossible, but after practice the work becomes easy. This form of exercise is usually prescribed in cases of distal occlusion, and the operator must here be careful in his diagnosis. (Fig. 9.)

The liability of overstimulating these muscles in the very young will be obvious to any of you who have thought at all upon this subject. Very little of this exercise is sufficient in the case of some, while in others it is almost

impossible to overdo it. Still further efforts are made for some patients, as shown in Fig. 10, and is a combination of a posture exercise of unusual merit, and the pterygoid exercise. The patient is directed after taking the position

Fig. 9-*A*.

Fig. 9-*B*.

Fig. 9-*C*.

here illustrated to stretch the point of the chin upward as far as possible, bringing vigorous strain upon the platysma myoides. Fig. 11 gives an example of the improved condition after a few months of this exercise in a case

of Class II. The only apparatus used in this instance was the upper lingual wire, through whose instrumentality the interference of a narrowed arch was removed. After the ability to place the teeth in proper relation had been acquired, the patient had another exercise added—that of the temporal and masseter muscles. This exercise consists of holding the teeth firmly in occlusion and alternately contracting and relaxing the groups of muscles shown in Fig. 12. In many cases it will be found that the ability to contract these

Fig. 10.

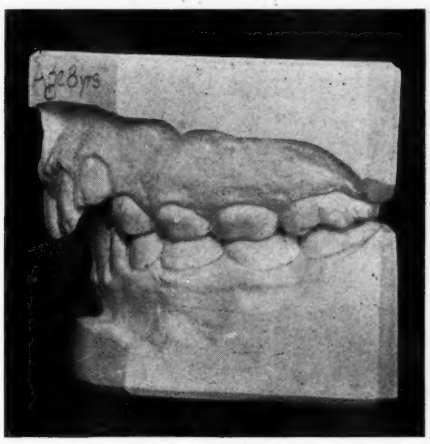

Fig. 11-*A*.

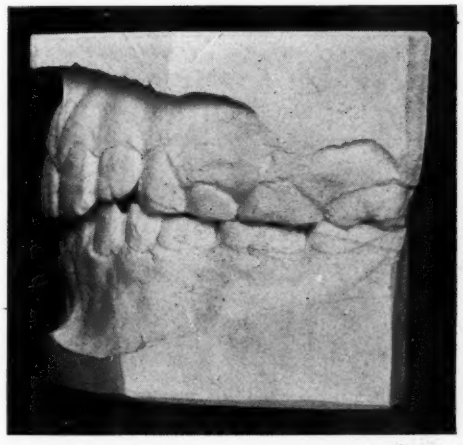

Fig. 11-*B*.

muscles is very slight indeed, but after a few months' practice, the operator is gratified to find greatly increased tone and improved control, as is shown by the ability to contract and relax. All efforts must be made with great concentration, and must be complete in their relaxation and their contraction. The ability to completely relax these muscles between each impulse is important to secure, as muscles exercised in this manner, for physiologic reasons, grow stronger much more quickly.

Fig. 13 shows a child in the act of stimulating these groups. The position of the fingers is useful, in the beginning, in teaching the child to detect the movements.

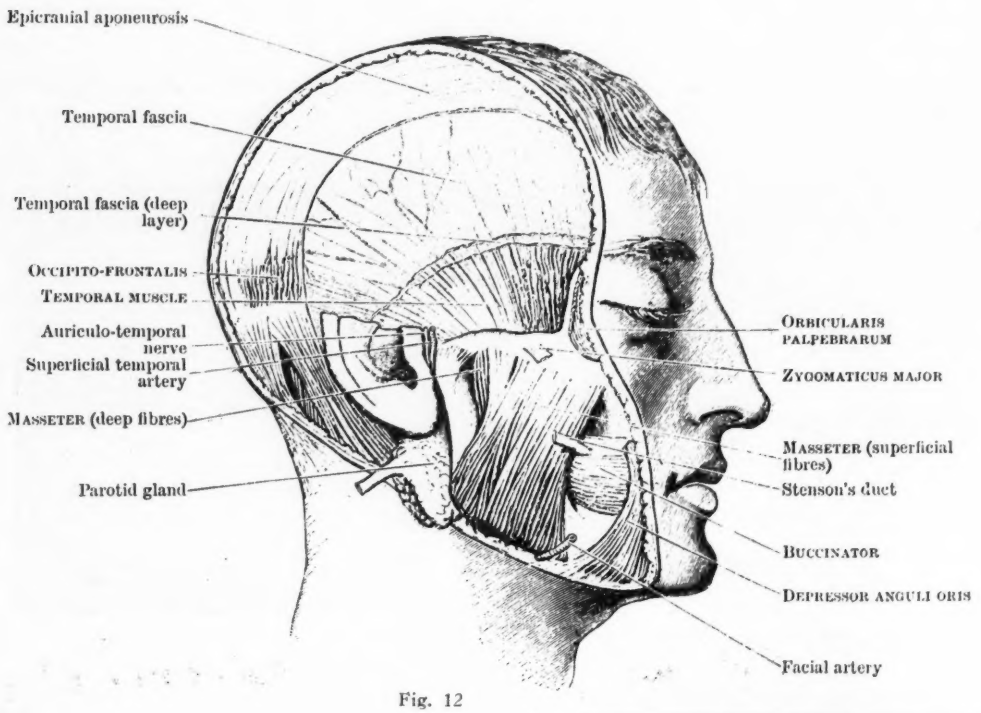

Fig. 12

Fig. 13.

Fig. 14.

Fig. 14 shows a form of exercise for these muscles which may be given when it is not wise to place the teeth in occlusion, and is used sometimes in anticipation of the exercise just described. It is performed by directing the

child to pit the muscles of mastication against those of the hand and arm, alternately contracting and relaxing.

Fig. 15 illustrates a case of a young child ten years of age, who was suffering from lingual occlusion of the upper bicuspids and molars. By the use of the lingual wire the upper arch has expanded until the lingual occlusion

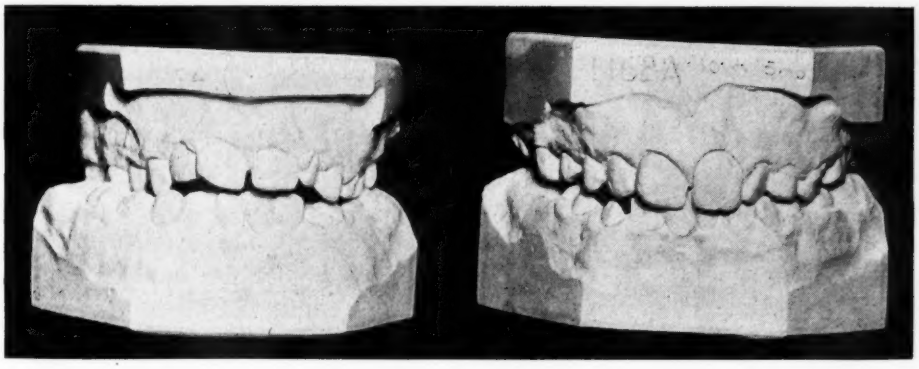

Fig. 15.

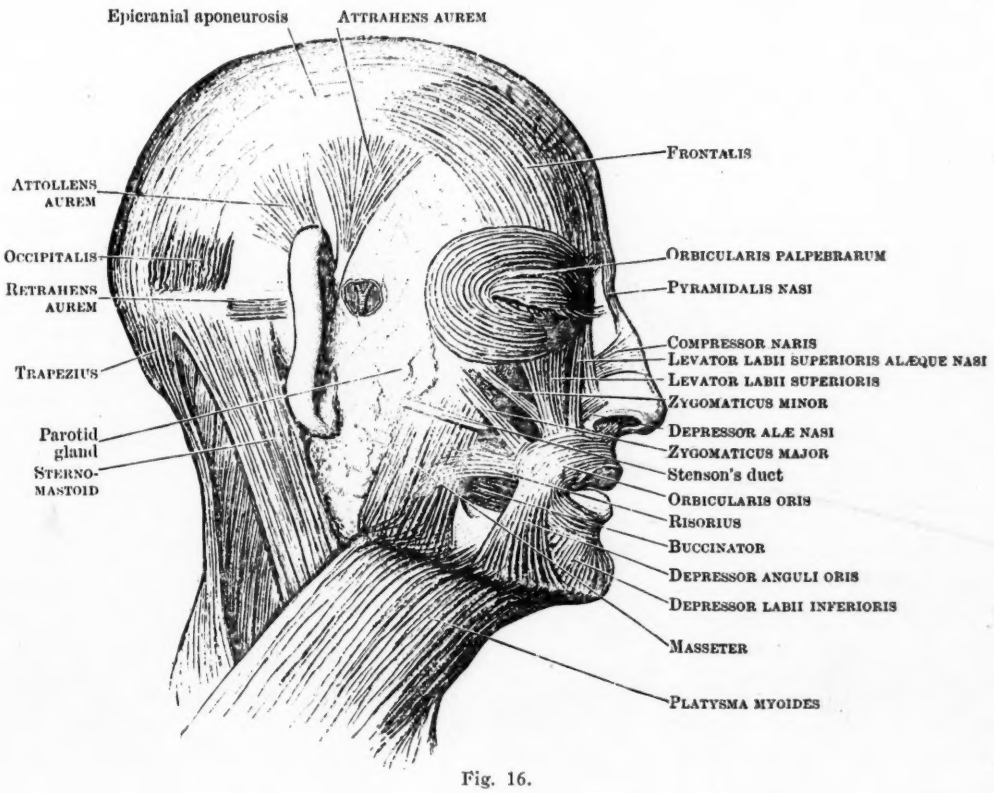

Fig. 16.

was disposed of. When this point of development was reached, as you will all readily understand, the condition of the open-bite was much exaggerated, and this is when the patient was instructed in the use of the exercise of the temporal and masseter muscles. The figure on the right represents this same case a few months later, showing the correction of the open-bite brought about

solely by this means. The child's ability to masticate has been wonderfully improved, and it may be said in passing that the high degree of nervous irritability, present at the start, has largely disappeared, and the child shows a generally improved physical condition.

Fig. 16 gives a general view of the lesser groups of muscles, but none the less important to the orthodontist. They consist of the levator labii, depressor labii, zygomaticus, orbicularis oris and platysma myoides. The names of some of these muscles indicate their function, and are perfectly well known to you. If they lack tone, or are not under control of the nervous system, they are the muscles which are most apt to place perplexing problems before the orthodontists. Most of these muscles are in some way attached to the orbicularis oris, and when we have a general lack of tone in all these muscles,

Fig. 17.

there is sure to be a lack of balance between them and the inner forces, such as the tongue. There are numerous exercises which can be used for stimulation of these groups, but it is not my purpose in this paper to deal particularly with these exercises. It might be well, however, for us to direct our attention to the orbicularis oris. Many of you, no doubt, have had difficulty in retaining the upper incisors in correct position. It is necessary, frequently, to apply retaining apparatus to effect this purpose, but if, in the meantime, this muscle has not been strengthened, in case it originally lacked tone, upon the removal of the retaining apparatus the incisors again become protruded. I have several cases in my practice where better results have been obtained in cases of this character without any retaining apparatus at all. One particularly obstinate case yielded to treatment applied for the strengthening of the orbicularis oris muscle. One valuable exercise I have found for strengthening this muscle is shown in Fig. 17, and consists in pitting the strength of

the thumb and first finger, or two first fingers, against the contractile forces of this muscle. Care must be taken in the performance of this exercise not to stretch, but rather to contract, the muscle around slightly separated fingers; thus ensues a contest of strength between the orbicularis oris and the muscles of the fingers.

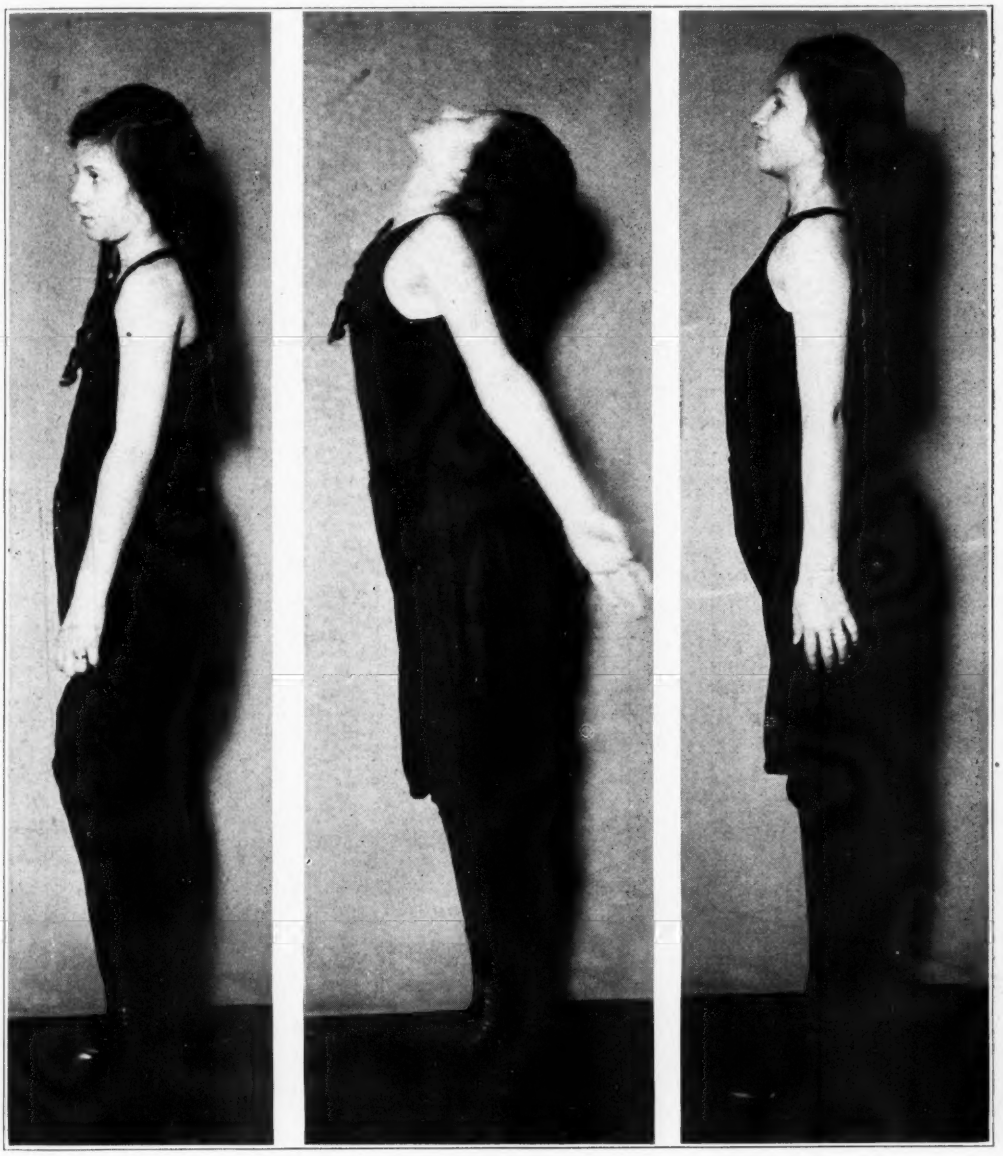

Fig. 18.

It is frequently found necessary to prescribe a tonic exercise, which I have termed the exercise for general facial development. This exercise influences not only the orbicularis oris, but also the buccinator and all the small ribbon muscles which enter into a combination with the orbicularis oris. It consists in the use of warm water at a temperature which is bearable to the mucous membrane of the mouth, and in which has been dissolved a small

portion of bicarbonate of soda. The patient is directed to take a sip of this solution, closing the teeth firmly in position, and with great energy forcing the liquid from the lingual cavity into the buccal. The exercise is usually done five times morning and night. The patient is directed to continue each exercise until the muscles are slightly fatigued. A not unpleasant aching sensation is the indicator of the successful effort. The heated liquid adds a distinct advantage to this exercise, as it has a tendency to dilate the blood ves-

Fig. 19.

Fig. 20-*A*.

Fig. 20-*B*.

sels, thus producing a more copious supply of nutritive material. At the termination of this exercise, the face will be found to glow with warmth.

The platysma myoides is one which, to my mind, is of great importance when considering the correction of faults in the facial muscular development. This muscle has no bony attachments but is inserted in the fascia and skin of the pectoral and deltoid muscles of the chest and upper shoulder at one end, and at its facial extremity is inserted by many fibers into the orbicularis

oris and some of the other muscles upon or near their entrance into the same. It will then be seen that, if this muscle is contracted in its length by the bad posture of the patient, it has a tendency to stretch the weakened muscles of the face in directions which bring gentle but harmful pressure upon the fragile bony structure of the child's face. The exercise for this muscle is found in the general posture exercise illustrated in Fig. 18, which consists in having the patient stand with feet together, hips slightly thrown back, directing the child to look straight to the zenith, at the same time drawing in the abdominal wall and turning the palms of the hands outward, making a slow and positive stretching motion with the tips of the fingers and the point of the chin. The child is then directed to relax somewhat, bringing the head and arms to erect position, then repeating the impulse. This exercise is done at first a few times in the morning upon arising, and a few times before retiring, and is increased until the child is able to do it sixty to one hundred times a day. It is important in this exercise that the child is not allowed to curve the vertebræ so that the back represents much of a concavity. To avoid this, the child is directed, when drawing in the abdominal wall, to tighten, at the same time, the muscles of the buttocks. A slight forward movement of the body, bending slightly at the ankles, thus bringing the weight of the body slightly upon the balls of the feet enhances the position of mechanical advantage in this exercise.

When a child is born, the earnest wish and hope of father and mother is that the child shall represent not only physical perfection, but mental strength as well. But the unconscious child has many an obstacle placed in his way by reason of the malevolent influences of civilized existence. His habits of body and mind, his tricks and manners of speech, the performance of his muscular acts, are allowed to develop without a conscious control. He has about him myriads of people presenting to him for his imitation, imperfect models. The parents very often are the greatest sinners in this regard. And so the subconsciously influenced organism develops more often than not along the road toward ill-health, completely unconscious of his own bodily disadvantages and mental handicap. Our schools struggle with backward children —backward in mind and body. There is some encouragement in the thought that there can be seen at the present time a tendency toward a reeducation both mental and physical.

The child whose picture I shall now show you represents a type which is all too prevalent among the children of today. (Fig. 19.) This child's history will be interesting for brief consideration. It will be readily noticed that not only the muscles of her face are maladjusted, but that there is no evidence of mechanical muscular balance throughout the whole body.

I next invite you to study the double picture of this same child, Fig. 20, after two months' following the instructions that I had given her respecting conscious guidance over muscular activity, together with orthodontic treatment for the correction of the malosseous development of the bones of the face and malocclusion of the teeth. The exercise, which this child has been taught to undergo, consists in gaining control of the pterygoid muscles and

control of the muscles of the trunk, particularly those of the abdomen. The picture showing the great improvement in this child does not represent the conclusion of the treatment, but simply represents the physical condition after two months of conscientious effort. The marked improvement in her physical being has its counterpart in her mental development, also. This was first noticed by the parents when their habitually backward child began to bring home reports of a very different mental alertness. The child's outlook on life has also shown a vast change, and she is learning to use those powers of mind which are responsible for right development physically, mentally and morally. Her obedience to my requests is prompt and earnest. This I have found generally true with all children who are not, by reason of some unfortunate taint, incapable of realizing the benefits which are bound to occur from this rational line of treatment.

The brief history of a few more cases will be interesting to you, I hope. It will be well at the outset for me to say that each of the three cases which I shall now present to you are undergoing treatment along the general lines

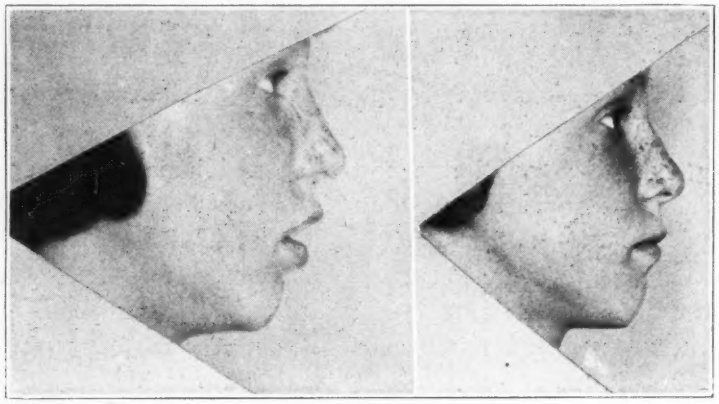

Fig. 21.

which I have indicated. The first is that of the case common in your practice—a child who has been operated upon by a skillful surgeon for the removal of adenoids and tonsils, and who has made the same mistake that the orthodontist has made in assuming that the child somehow or other subconsciously gains control of the distorted and ill-draped facial muscles. The interesting point about this child is that, being a subdivision of Class II, with upper laterals in slightly lingual occlusion, she is being treated without any apparatus whatever, and satisfactory progress is being obtained. The lapse of time between these two pictures, Fig. 21, represents a period of about six weeks. Her distal occlusion is no longer apparent, the muscles of her face are becoming firm and well established in their normal positions.

This is evidenced not only by the improved muscular balance of the orbicularis oris and its attached muscles, but also by the improved contour and the region occupied by the masseter muscle. The exercises which this child is undergoing are the general posture exercise, the pterygoid exercise, masseter exercise, and exercise for the tongue, in obtaining and maintaining the

full development of the lower arch, and balancing the forces of occlusion brought into existence by the control of the masseter and temporal group.

This illustration (Fig. 22) is of a boy eleven years of age, an extreme case of Class II, one of those cases where the persistent use of intermaxillary elastics, followed by a long course of mechanical retention is so often unavailing. The treatment of this case consisted in using the general posture exercise and the pterygoid exercise. Later on, when the muscles had become accustomed to placing the mandible in its normal relation with the rest of the skull, small inclined planes were placed upon the anterior teeth. His future treatment will consist of a continuation of these exercises, with the addition of the temporal and masseter and those of the muscles of expression, including the orbicularis oris.

In Fig. 23, the profile on the left shows a child with slight distal occlusion.

Fig. 22-*A*.

Fig. 22-*B*.

It will be noticed that the muscles around the mouth are poorly developed, and evidently not under proper nervous control. The picture on the right shows this same patient after completion of the treatment. This patient has now very satisfactory muscular development. The figure on the right also shows the improved contour and the more normal nervous control of the muscles of the face. This patient has developed an unusually fine set of masticatory muscles where, when the case was started, these muscles showed very little development. In Fig. 24 the model on the left shows this case before treatment, and on the right the result at the completion of the treatment.

I reserved for your consideration a case (Fig. 25) which has given me much encourgement, and I feel that this child, like the three preceding cases, has been doing and is doing her part in helping to establish the importance of the matter which I have been presenting to you today. They have all four been faithful and earnest in the application of the advice I have been giving them, and their mental alertness and interest have gone apace with their improved mental condition. This child, as you see her, before supplying the

rational treatment, suffered from a severe case of protrusion of both upper and lower incisors. She was treated and retained over a period of several years by a man of unusual attainment in orthodontia, but the muscles were not trained or developed in any way. The difference in time between the first and last pictures represents a period of about ten months, and the satisfactory result with respect to the correction of malocclusion is found in the fact that no mechanical retention has been necessary in order to maintain both the upper and lower incisors in their normal position. The difference in muscle

Fig. 23-*A*.

Fig. 23-*B*.

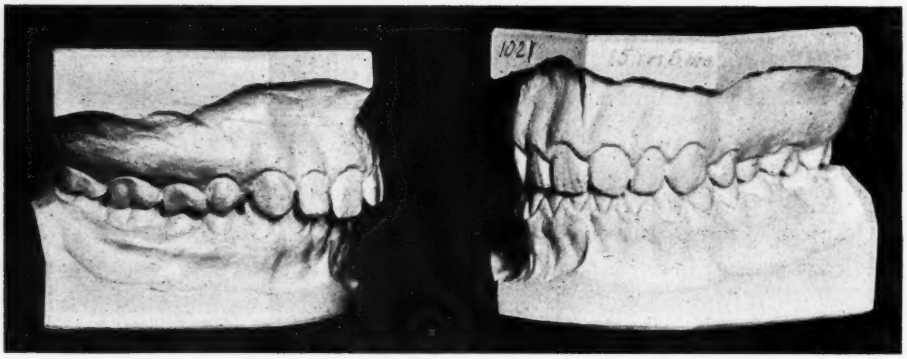

Fig. 24.

tone and control between the first and last picture has been sufficient for the purpose of retention. It will hardly be necessary for me to indicate definitely the other points of improvement in this face; the more you study, the more nearly it will be seen to approach the graceful, well-poised face that nature intended this girl to enjoy. A contemplation of a side view of this same patient (Fig. 26) representing the same period of treatment, will be found even more interesting than the study of the front view. The muscular improvement will be seen to have taken place in the masseter, submandibular, synthesis, orbicularis oris, and the nose. All these points show marked improvement

upon a casual examination. The improvement in the tone of the muscles evident upon a digital examination, is quite marked.

It will not be necessary for me to go further in order to convince you of the value of these experiences along the line of muscular control in con-

Fig. 25-*A*.

Fig. 25-*B*.

Fig. 26-*A*.

Fig. 26-*B*.

junction with a simplicity in the construction and manipulation of orthodontic appliances.

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THE REMOVABLE LINGUAL ARCH AS AN APPLIANCE FOR THE TREATMENT OF MALOCCLUSION OF THE TEETH*

By John V. Mershon, D.D.S., Philadelphia, Pa.

IT is a well-known biological fact that to have normal development of the tissues and organs of the body, we must have normal function of these tissues and organs during the process of development.

Anything interfering with the forces which produce these functions will interfere with the functions, and just in proportion as we have a disturbance of function we will have a disturbance in development.

Malocclusion of the teeth or maldevelopment of the facial bones is quite likely the result of a perversion of or some interference with these functional forces, and the orthodontist is endeavoring to correct these deformities and restore these functional forces with orthodontic appliances. These appliances are effective just in proportion as they apply force in the direction of normal growth, and in so doing do not interfere with the function of any of the tissues associated with the teeth, or with the teeth themselves collectively or individually, each tooth being left free to functionate normally.

The direction of normal growth of the teeth and facial bone are, forward, outward and downward in the upper jaw: forward, outward and upward in the lower jaw.

The appliance in which the application of force is in these directions and which does not interfere with any of the associated functional forces, would be the ideal appliance. I am going to ask your consideration of the removable lingual arch as the appliance which seems to possess many of these qualities.

Occupying a position on the lingual surface of the teeth and at the gingival border, with all the teeth free to functionate normally (except the two molar teeth to which the arch is attached), the appliance develops a force which operates from the lingual side and is in the direction of normal growth, and the muscles of the lips and cheeks are left free to functionate normally.

THE ARCH

The removable lingual arch is a wire of suitable size, to which auxiliary springs can be attached, adapted to the linguo-gingival surfaces of the teeth, and bent to conform to all the inequalities of the dental arch, produced by the irregularities of the teeth. It is fastened to the lingual surfaces of the molar bands by means of the Young-Angle lock with certain modifications. This lock has proved most valuable to the profession, and we are greatly indebted to the developers of it. I have modified it by using a half round tube in place of the elliptical one. The lock is a wire soldered mesial to the tube, instead of being formed by bending the portion of the arch which is distal to the tube to change it gingivally.

*Read before the Eighteenth Annual Meeting of the American Society of Orthodontists, Chicago, Illinois, August 1, 2, 3, 1918.

CONSTRUCTION OF THE ARCH

The arch is constructed on a plaster model made from a good impression, bands having been previously fitted to the anchor teeth (usually the first molars). These bands are transferred to the corresponding teeth on the plaster model, with half round tubes soldered at the proper location on their lingual surfaces.

BENDING THE ARCH WIRE

We start at the half round tube, allowing the arch wire to extend about one eighth of an inch, distally beyond the tube. Just mesial to the tube we make a compound bend in the wire, first to the gingiva, then again bending the wire parallel with the gingiva, and continuing along the lingual surfaces of the teeth, as close to the gingiva as possible, without impinging on the same, adapting the wire to all the irregularities of the dental arch, until the tube is reached on the anchor band on the opposite side, when the arch is cut off one eighth of an inch distal to the tube.

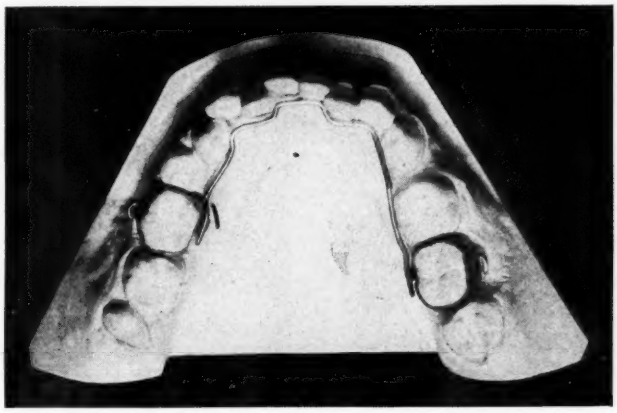


Fig. 1.—Lingual arch bent to conform to the lingual surfaces of the teeth.

LOCATION OF HALF ROUND TUBES ON MOLAR BANDS

The tubes should be placed on the lingual surface of the anchor bands, usually in the center of the band meso-distally in both upper and lower jaws. In the lower they should be placed as near the occlusal edge of the band as possible, allowing only sufficient distance between the occlusal edge of the band and the top of the tube for the arch. This is so placed for the reason that the post is easier to place in the tube if it is not too far toward the gingiva, as it is difficult to see the tube in the lower on account of the tongue and saliva. In the upper jaw, the tube should occupy the same position meso-distally, but should be placed as near the gingiva as possible, otherwise the lingual cusps of the lower molars will come in contact with the arch, and the continuous biting on it will eventually cause the arch to break.

SOLDERING OF THE HALF ROUND POST

The post consists of a half round wire soldered to the arch and accurately fitting the half round tubes forming a portion of the lock.

For convenience in soldering, a long piece of half round wire is selected. Place the arch accurately on the model, mark the arch opposite the tubes, then solder the post to the arch opposite the mark, in the usual free-hand manner, cutting off the half round wire just a little shorter than the tube, leaving a catch for the lock wire. Then place the half round post wire in the tube on the molar bands on the model. If the arch should not lie correctly on the model, remove it, and with two pairs of the Young pliers it can be twisted to the desired position. Proceed in the same manner soldering the half round post wire on the opposite side. The arch is again replaced on the model with both pieces of the half round post wire in the tubes. If the arch should not be well adapted or be raised away from the model, direct the flame of the blow pipe on the arch, heating it to a cherry red, and while hot, pressing with a suitable instrument on the arch it can be readily adapted to the model.

The lock consists of a wire of suitable size, soldered to the gingival surface of the arch, twenty one hundredths of an inch mesial to the half round post, passing it distally to catch under the gingival surface of the tube, thereby preventing the post coming out of the tube. After polishing, the arch is now ready to place in the mouth. Remove the anchor bands from the plaster model

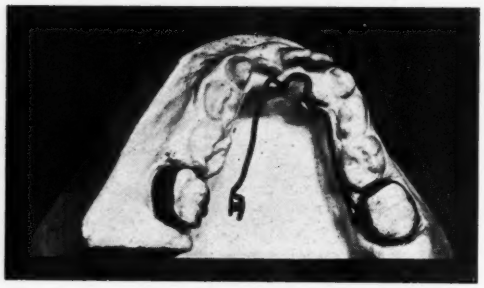


Fig. 2.—Trying in the arch, showing incorrect position.

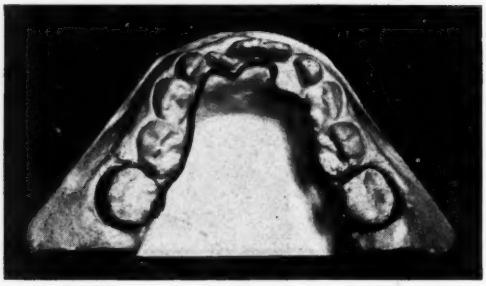


Fig. 3.—Trying in the arch, showing correct position.

and cement them on the teeth. In trying the arch in the mouth, grasp the arch on the left side in the region of the half round post, with a pair of Howe pliers, and place the post in the tube on the left side. The arch should lie in its proper position, with the half round post on the opposite side parallel with the half round tube. Should it not fit properly twist or bend the arch until it lies correctly (Fig. 2). Remove the post from the tube on the left side, then place post on the right side in the tube. If the post on the left side drops in place in the tube, then the arch is ready to be locked in place (Fig. 3).

MATERIAL AND SIZES

The size of the wire for the arch which has proved most satisfactory is thirty-six one thousandths, or nineteen gauge B. & S. For the lock, twenty-six one thousandths is used. The half round tubes are ten one hundredths of an inch long, and the post wire sixty-four one thousandths by thirty-two one thousandths.

The arch wire should be hard, with a good spring, and sufficiently tough to stand bending and rebending, also to stand stretching with the pinching pliers without breaking. It should also possess the quality of softening by anneal-

ing, and retempering again, and be sufficiently high fusing to stand soldering with a high carat solder. Some of the gold and platinum alloys on the market today possess all these qualities; the half round tubes, the post wire, and the wire for the auxiliary springs, are all of the same material as the arch itself.

THE AUXILIARY SPRING

These springs are wires usually twenty-two one thousandths of an inch, soldered to the main arch wire to produce individual tooth movement.

PROPER LOCATION OF THE ARCH

The arch should occupy a position on the lingual surface of the teeth as close to the gingiva as possible, and made to conform to all the inequalities produced by malocclusion.

THE USE OF THE ARCH

I shall only consider treatment in so far as it consists of general arch development, and tooth movement in the individual arches.

The arch when first placed in the mouth should be passive, the patient be-

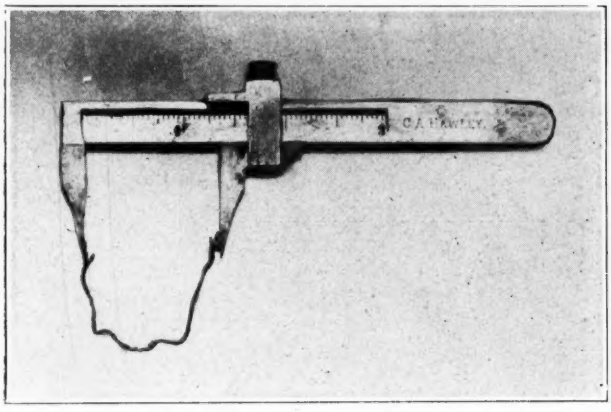


Fig. 4.—Illustrating method of measuring with Hawley calipers.

Fig. 5.—Showing arch after kinks had been taken out. Same arch as in Fig. 1 with bends taken out.

ing allowed to wear it long enough to become entirely accustomed to it which is usually a week.

During this period children are more likely to play with the arch with the tongue, or fingers than thereafter. Therefore, very strict caution should be given both patient and parent regarding this evil, as well as against eating sticky candy. After these precautions, I seldom have trouble, but should I have trouble at the next visit I fasten the arch with a fine ligature wire to some favorable tooth and this usually cures the trouble after the patient becomes accustomed to the appliance. I seldom find it necessary to band teeth to keep the arch in place.

TREATMENT

The force necessary to produce tooth movement with the lingual arch is obtained in three ways. One by straightening out the inequalities in the arch

wire; another by auxiliary springs soldered to the main arch; a third by stretching the wire by means of the wire stretching pliers.

After removing the arch from the mouth the procedure of adjusting it consists of taking a measurement of your arch from one post to the other (Fig. 4). This is most important, and is best accomplished by a pair of measuring calipers such as Dr. Hawley used with his charts.

After this is done, retain the calipers for measuring before replacing the arch. I have above stated, the arch must conform to all the inequalities produced by the irregularities of the teeth which necessitates a great many bends and curves in its length. We now proceed to take some of the bends and curves out of the arch (Fig. 5). This is best accomplished by a suitable pair of flat-nosed pliers. Each time you remove one of the bends or curves the

Fig. 6.—Same model as Fig. 1 after 15 months' treatment.

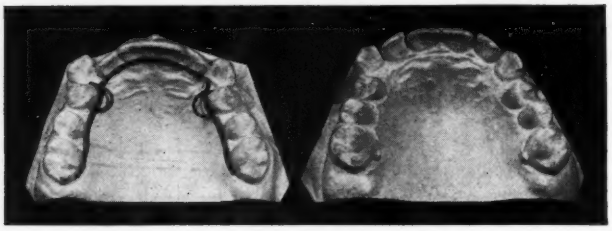


Fig. 7.—Spring method of rotating upper first bicuspids. *A*. Showing springs in position. *B*. Showing results of two treatments.

size of the arch is increased. When you replace the arch, by placing the posts in the half round tubes there is a general forward and outward pressure on all the teeth, that require moving outward or forward (Fig. 6). Your object at each treatment is to conform the lingual arch more nearly to the shape you expect the dental arch to be when completed. It is astonishing how little change is required at each treatment. As you straighten out a curve which was toward the lingual to conform to a tooth that was lingually placed, on replacing the arch the most pressure naturally comes on that tooth, and it is in this way that we obtain an outward pressure. After making the adjustment in the arch, before replacing it in the mouth, always measure across from one post to the other with the calipers with which you have previously measured, and set, noting that you have made no change in this region, unless you wish expansion of the molars. After making this change in the arch, it is interesting to note

that when replaced in the mouth and locked into position, the arch will push a little harder on the teeth you wish to move into the line of occlusion with a beautiful reciprocal force. Continue in this manner from time to time, either broadening or lengthening the arch or both as desired, until the teeth have been moved to their desired position.

AUXILIARY SPRINGS

These springs are usually soldered to the gingival side and at right angles to the main arch, and are then bent in the direction in which you wish to apply force. The reason for soldering the springs at right angles to the arch and bending them is, that in soldering, the high heat removes the temper from the wire, while the bending to correct position restores the spring temper. The general developing and shaping of the dental arch is best accomplished by the reshaping of the main arch.

Individual tooth movement is best accomplished by the individual springs.

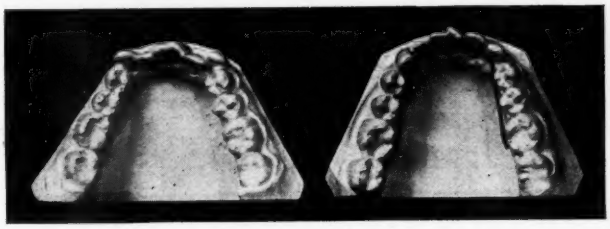


Fig. 8.—Showing rotation of cuspid without bands by the use of auxiliary springs. *A*. Original model. *B*. Showing cuspid rotated.

Fig. 9.—Front view of Fig. 8.

ROTATIONS

For rotation without banding the teeth let us take as an example the upper first bicuspid which frequently erupts with the lingual cusp rotated mesially (Fig. 7). This is very easily corrected by soldering a spring to the main arch, opposite the approximal space between the first and second bicuspid. Bend the wire mesially forming a half circle, with the free end of the spring wire engaging the first bicuspid with pressure on the mesial surface opposite the lingual cusp.

The spring wires are quite long and you can give a good deal of spring to them, and on account of the small gauge of the wire it will be a very gentle force, effective for a long period of time, often as much as two months.

Rotated cuspids can in many cases be corrected without banding the teeth. Allow the lingual arch to rest with slight pressure against that angle of the tooth which is rotated toward the lingual (Fig. 8). At this point solder

a wire spring pointing occlusally, bending the spring wire labially to pass between the cuspid and the adjoining tooth, and continue the bending toward the gingiva, allowing the loose end of the wire which has been properly shaped therefor to engage with pressure the labial portion of the cuspid which is rotated labially. (Fig. 9.) A large proportion of such rotations can be corrected in this way.

A method employed where the case can be seen infrequently is to band the tooth to be rotated in the usual way, with a spur attached to the labial side of the band, (Fig. 10). A spring wire of twenty-six one thousandths is soldered to the arch some distance from the tooth to be rotated and the spring is bent almost parallel with the main arch. On the loose end which should now stand some distance from the arch, place a fine ligature wire, which passing through

Fig. 10.—*A.* Showing auxiliary springs for rotations when a case can be seen infrequently. *B.* Showing result after being wired once and allowed to remain a number of months.

Fig. 11.—Method of opening spaces with auxiliary spring. *A.* Showing spring in place, with the straight one showing how they should be soldered before bending. *B.* Showing result of treatment.

the gingival space, engages the spur on the band. After this the ligature wire should be tightened until the spring is in contact with the main arch. It is well to make a bend at the end of the spring wire so the ligature will not slip off. The tendency of the spring wire to return to its original position will cause the tooth to turn on its axis.

ANTERIOR ROTATIONS

To rotate central and lateral incisor teeth, use a grass line by ligating the tooth, then passing one end around the arch and back through the gingival space tying the two ends firmly together. The contraction of the grass line will cause the tooth to turn. In younger cases the lingual arch will frequently correct a rotation of the anterior teeth, simply from the light pressure of the arch resting on the corner of the tooth rotated lingually.

The lips being free to functionate are pressing on the labial portion of the same tooth and are assisting in correcting the rotation.

ROTATION OF THE FIRST MOLARS OR ANCHOR TEETH

Of all the teeth, the correct rotation of the first molars I consider the most important. When they are used as the anchor teeth, this is easily accomplished by making a very slight bend in the arch wire where the half round post is attached. The molar roots or crowns can also be tipped buccally or lingually by grasping the arch mesial to the post with a pair of Young Pliers. At the same time with another pair of pliers grasp the arch where the post is soldered to the arch,

Fig. 12.—*A.* Showing auxiliary springs for labial movement of laterals, one in correct position, the other just before bending in correct position. *B.* Showing result of treatment.

Fig. 13.—For mesial or distal movement of anterior teeth.

Fig. 14.—Auxiliary springs for lateral development in deciduous denture.

giving a very slight twist in the direction you wish the movement, caution always being taken that you do this exceedingly slowly or you may cause your anchor teeth to loosen. This precaution should be taken at all times in using the lingual arch, as it is very easy to place great strain on your anchor teeth.

To overcome this it is wise to solder a spur on the arch to engage the mesial surface of the first bicuspid. This greatly relieves the strain on the molars, as you can increase or diminish the pressure of the spur at will.

TO OPEN SPACE FOR IMPACTED TEETH OR MISSING TEETH

This is accomplished by two auxiliary springs, soldered to the arch, one the width of a tooth distal to the place you wish the space, the other the

width of a tooth mesial to the space, making the two springs the width of two teeth apart. The one most distal curves mesially to engage the one tooth, while the mesial one curves distally to engage the other tooth. (Fig. 11.)

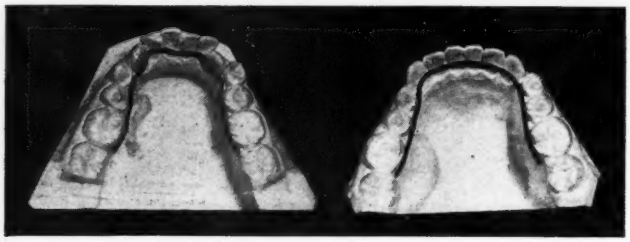
The spring should always be soldered at right angles to the arch before bending into the half circle.

With the loose end of the spring flattened by disking the sides, this end usually passes to the gingival side of the arch to engage the teeth.

LABIAL MOVEMENT OF TEETH

To move laterals labially a spring is soldered to the arch, opposite the median line, then bent to the right or left to engage with pressure the lingual surface of the lateral that is to be moved. (Fig. 12.) To move the anterior teeth mesially or distally, solder a spring to the arch about fifteen one-hun-

A. *B.*



A. *B.*

Fig. 15.—Showing case before and after treatment. *A.* Original model. *B.* Same model and arch after treatment.

dredths of an inch distal to the tooth to be moved. (Fig. 13.) Bend the spring in a curve passing the loose end, which should always be flattened by disking both sides until it is very thin, to the gingival side of the arch, and if properly adjusted (this is most important in all of the auxiliary springs) it will pass between the tooth and the soft tissues at the gingival space in the same manner as a thin band. Tooth movement is very easily accomplished if slight pressure is applied to the tooth by tightening the spring from time to time.

The auxiliary spring is very useful with the deciduous denture where we are desirous of obtaining lateral development from one deciduous cuspid to the one on the opposite side. (Fig. 14.) Adapt the arch to the lingual surfaces of the teeth, soldering springs on both sides to the gingival side of the arch, as near the lock as possible. Bend each spring wire parallel with the

arch to engage the deciduous cuspid by flattening the end of the spring and bending it toward the gingiva to fit around the linguo-gingival ridge of the tooth. With the proper adjustment of the springs the desired development can be obtained.

One very interesting feature of the lingual arch is that in moving teeth you seldom have tipping of the teeth, and when you do it is very slight; that is, unless you have been unwise and hurry your work faster than normal development.

The reason the teeth do not tip probably the fact that the arch occupies a position to the lingual of the teeth at the gingiva, pressing forward or outward or both as you desire, with the lips and cheek muscles left free to functionate normally, and every contraction of these muscles causes pressure on the incisal edges of the teeth. Every tooth left free to receive the normal occlusal impact during mastication, produces a normal functional bone development causing the teeth to be carried bodily forward.

In a great many cases the amount of wire from one half round post to the other is just the amount desired. (Fig. 15.) If it should not be sufficient, the one-eighth of an inch that extends beyond the tubes can be utilized by unsoldering the post and resoldering as far distal as necessary to give the de-

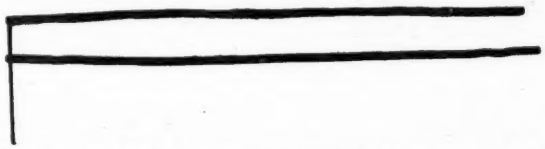


Fig. 16.—Arch wire in case in Fig. 15, lowers straightened out, showing difference in length of wire from distal surface of first molar on the completed case, and the case when started, showing how much is gained in length by straightening out the loops.

sired length of arch. (Fig. 16.) If for any reason this is not sufficient, or in case of a broken or lost arch, take an impression in modeling compound which will show the tubes, and a new arch can be made very quickly, and by slight adjustments in the mouth can be fitted nicely.

RETENTION

My conception of orthodontia is that we are not only trying to restore teeth to what we have termed normal occlusion, but to restore the tissues and organs which constitute the oral cavity to normal function. From the time you start to treat a case of malocclusion with the lingual arch, until it is finished, it might be considered a continuous retainer, as it interferes so little with normal functions, and is constantly assisting in the development of these oral tissues in the direction of normal growth where nature has failed.

This paper is by no means a complete analysis of the removable lingual arch, but is only intended to show that tooth movement can be produced.

I have not touched on its use in connection with the labial arch, or by the use of the wire-stretching pliers, as this has been so ably presented by Doctor Lourie.

THE LAW OF OCCLUSION AND THE NORMAL IN ORTHODONTIA*

A Philosophic Survey of Recent Tendencies in Orthodontia in the Light of Science

By A. LeRoy Johnson, D.M.D., Springfield, Mass.

IN MODERN orthodontia there has developed a tendency to absolute methods and absolute claims as to the results of treatment. And it requires no violation of reason to see in such methods the logical extremes of the doctrines upon which orthodontia was founded. With its inception in mechanical dentistry during that period of philosophic thought when diversity of form was entirely attributed to environmental influences such conclusions as the following were natural. They are the dominance of the mechanical influence of cusp relation in the development of occlusion; the inherent tendency of all organisms to evolve a definite type, harmonious in design, and the equal potentialities of development of all organisms. In the light of advancing science, and a deeper knowledge of the forces governing occlusion derived from practice we can no longer allow such doctrines to pass unquestioned even though they still express an element of truth.

The masticatory apparatus is a living part of a living thing and so is subject to the same general laws as are other parts of the organism. Hence the knowledge of its growth and development and the interpretation of such knowledge in terms of practical utility must conform to the methods and material of science in general.

The following is an attempt to express in terms of science the fundamental principle of orthodontia and the nature of the normal as it refers to the species and to the individual. In the subject matter is embodied a criticism of the doctrines referred to above.

The line between common knowledge and scientific knowledge is not easily drawn. To say that science is organized knowledge is not enough, for the commonest acts of everyday life are in greater or lesser degree organized. It can not be said that science is the more exact for much common knowledge is exact. Common knowledge may be just as precise as scientific knowledge but in order that it be scientific it must be precise. Science reduces other knowledge to the same degree of precision. From one point of view science may be called an extension of preception by means of reasoning. It is prevision. A child who knows that a lighted match thrust into water will go out, and the astronomer who, having calculated a transit of Venus, can delineate the black spot entering the sun's disc, do the same thing. Each has a preconceived impression of what will happen upon fulfilling certain requisite conditions. The difference is in the complexity of the process to see the result.[1] In

*Read before the Eighteenth Annual Meeting of the American Society of Orthodontists, Chicago, Illinois, August 1, 2, 3, 1918.

reality it is a difference in degree only. One is merely an extended and perfected form of the other. Science defined is knowledge which has been systematized and formulated with reference to the discovery of general truths or the operation of general laws. Science exists because in order to foresee the result of a complex process it is essential that the knowledge referring to this process be arranged in conventional form.

The material of science is accumulated as the result of observation, comparison and experimentation and the methods employed are referred to as either qualitative or quantitative. The prediction that a piece of lead is heavier than a piece of wood of equal size, is the qualitative method. It exhibits certainty but not completeness of foresight. On the other hand, the prediction that water will freeze at 32° F. shows foreknowledge not only of the effect to be produced but of the magnitude at which the effect will be produced. This illustrates the qualitative and quantitative methods combined. The quantitative method applies a definite measure to phenomena as in the use of thermometers, scales, dynamometers and as in the modern methods of experimental analysis. Hence, only in proportion as knowledge becomes quantitative is it especially scientific. Only in the degree that it is measurable is it scientific in the highest sense and do its previsions become complete as well as certain.

From another aspect passing from qualitative to quantitative is passing from inductive science to deductive science. Inductive science is qualitative; it is reasoning from the individual to the universal. Induction gives general principles derived from the observation of individuals as in the formation of a natural law. Deductive science is quite the opposite from inductive science. It is reasoning from the general to the individual. Deduction gives explicit knowledge, it measures. Although deductive and quantitative methods are not coextensive all quantitative prevision is reached deductively. The first stage of all science is inductive but after continually applying this method with constant results, deductively the results of observation may be approached. The history of physiology and morphology shows many instances of the legitimate use of this method. The knowledge of the presence of the vascular and nervous system was inductively established and from this it has been possible to draw certain general deductions.

Thus do common knowledge, qualitative and quantitative science stand in the orderly sequence of their evolution. It is essential to grasp the significance of this sequence and also the distinction between qualitative and quantitative methods of scientific work. The quantitative work that has been done during the last quarter or possibly half of a century has upset many of the philosophical generalizations expressed even now in orthodontic literature.

From the definition of science it is clear that the selection and utilization of knowledge in each branch of science is determined by its relation to the general truth or law which gives to a particular science its distinctive character. In short all science is founded upon a general truth or law. In organic science the basic principle is referred to as a natural law.

A natural law or law of nature means nothing more than that there exists a uniformity in a certain phase of natural phenomena. It is the result of

inductive or qualitative study, i. e., from the observation and comparison of many individual cases there is evident a certain uniformity of phenomena. In the words of Herbert Spencer, "A natural law is the uniformity seen in the diversity of organic forms."[2]

Now, orthodontia like all other branches of science is founded upon a general truth, a natural law. As a result of the study of many organisms, from the observation and comparison of the growth and development of the masticatory apparatus of the individuals of many species there is seen to be a certain uniformity of phenomena. From the viewpoint of inductive reasoning and as a result of qualitative study the order of sequence of the phenomena is seen to be so invariable under normal conditions that a uniformity is readily recognized. And since the mechanical relation of the occlusal inclined planes of the teeth, typical for the species, is the goal of the growth and development of this part of the organism, the uniformity, the natural law (manifest in the growth and development) we call the law of occlusion. Therefore, the law of occlusion is the general truth, expressing a uniformity seen in the diversity of organic forms, upon which the science of orthodontia is founded. It is the basic principle about which the knowledge of the growth and development of the masticatory apparatus, the subject matter of orthodontia is systematized and formulated into a science.

It is not an uncommon procedure in practice to confine the study of the orthodontic case to a consideration of the occlusal relations of the teeth. A concept called normal occlusion is the measure laid upon each individual case and as the occlusal relations depart from this normal occlusion the teeth are said to be in malocclusion requiring treatment. To arbitrarily determine the ideal relation of each individual inclined plane and then, by virtue of the plastic nature of bone, to mechanically conform all variations to this ideal relation, is, like many half truths, beautifully simple. And in this comparatively easy way the question is often disposed of.

The obvious unsoundness of such procedure is further emphasized in the diversity of opinion manifest in the literature as to the idea conveyed by normal occlusion. To some it is a concept derived from the study of dead forms, prehistoric skulls and lower species; a purely mental concept, a hypothesis, when applied to modern man. To others it is a condition of greatest occlusal contact for the individual case while a few consider normal occlusion as synonomous with natural occlusion. However, the latter do not confine their exposition to that which is typical of the species.

This confusion of ideas is due to a loose interpretation of terms and to the fact that studies of harmonic conditions of development have been limited almost entirely to organisms of a different nature or living under different conditions from the human organism of today. The conception of the normal has not been the result of evidential reasoning according to scientific standards.

What then is the meaning of the word normal? As the term is used in different branches of science slight variations in sense, appear, according to the nature of the material it is expressive of, and, also, as emphasis is put upon the words chosen to convey its meaning, as rule, standard, model, type

or pattern. In chemistry normal denotes a solution of definite character; in geometry normal refers to any perpendicular line; in economics normal and natural are often used synonymously but the use of the word natural invokes certain metaphysical assumptions which are not connoted by the term normal; in biology normal is the balance of activity, growth and repair. Although the word is used differently in the different sciences, in each science its use conveys a definite idea. So in orthodontia where the word normal plays such a vital role in terminology it is essential that it be used in as restricted a sense as possible.

In Webster we find that normal "is according to, constituting or not deviating from an established norm" and that a "norm" is a rule or authoritative standard. As used in the organic sciences normal is according to, constituting or not deviating from a standard or rule which is observed or claimed to prevail in nature. The normal then is not synonymous with natural; it is a standard derived from a study of the natural.

Then if normal occlusion is to be a scientific guide in orthodontia, it must be a standard derived from a study of natural forms. Moreover it must be a standard derived from a study of natural forms as manifest in the human masticatory apparatus as it lives today in the 20th century. It is not a standard derived from the study of fossil forms, prehistoric skulls and lower species. A knowledge of such material is included in that larger concept the law of occlusion, and is necessary to an understanding of the phenomena encountered in the study of the human denture. But the material which determines the standard, the normal, which is to be taken as a tangible guide in diagnosis must be derived from the material we work upon.

The condition of the organized world is not a fixed condition; it is constantly changing. The man of today is not the man of yesterday. Changed conditions of living have caused some parts and organs to become less essential to existence. Until as Bateson says "We, animals, live not only by virtue of, but also in spite of what we are. Any instinct or organ may be of use; the real question is of how much use it is."[3] In view of the diversity of form manifest in the human masticatory apparatus we may well question "of how much use it is." Do not misunderstand me. I do not infer that normal occlusion is not essential but that in the life history of the human organism and the present condition of its denture there is evidence of its not being as vital to existence as it was and is to those organisms from which the popular conception, the old orthodox ideal occlusion has been derived; the same conception that has been responsible for the belief in the dominance of the mechanical influence of cusp relation in the development of the dental arch. It seems quite obvious then that the conception of normal occlusion, typical of the species, as a scientific guide must be the result of the study of the masticatory apparatus of many human beings, living in states of health under the complex conditions of modern civilization. It is a standard derived from statistical investigation.

Today the most conservative thinkers do not question the natural tendency of all organisms to vary. The structural relations of one are not identi-

cal with those of another. Hence in orthodontia we are forced to believe that the normal occlusion for the species, i e., an average typical condition of cusp relation, determined by statistical investigation, and the normal of the individual are not necessarily the same. In the majority of cases we may reasonably expect to find a natural difference between the species normal and the normal of the individual. And thus we are led to one of the most momentous questions of orthodontia, to determine the normal of the individual, to ascertain the range of variation from the normal of the species which is consistent with the most complete realization of the growth and developmental possibilities of the individual organism as a whole. A definite solution of this problem is not anticipated in any instance, in fact the absolute claim is unwarranted. But because now it seems hopelessly beyond our reach is no reason why we should not face the facts of science, utilize its available material and conform our efforts to its methods.

To determine the normal of the individual is a difficult problem. It involves the consideration of phenomena fundamental in organic life. And a scheme of investigation or system of diagnosis which will indicate the individual normal and so in a degree at least anticipate the possible and the impossible in treatment, must be built upon a knowledge of normal and pathological processes as they are expressed in growth and development. We can not postulate the role of pathology as an etiologic factor of malocclusion until we are familiar with normal processes. These latter include such fundamental problems of biology as the interdependence of function and structure; variation and adaptation; heredity and the unity of the organism as a whole. In the material of science relating to these so-called normal processes the individual element in the organism is clearly emphasized.

From the viewpoint of philosophy the life of the individual organism is a continual balancing of external by internal forces. Fisk says, "that it is the continuous adjustment of internal to external conditions."[4] Spencer expresses the same thought in different terms. Thus each consider two kinds of equilibration briefly designated as internal and external. Fisk referring to the internal processes says "we see that direct equilibration which consists in continually arranging all the units of the organism in accordance with their physiologic polarities, exemplified alike in heredity and in the correlation of growth. The dwindling and final evanescence of organs which are disused is due to the fact that the nutritive material is all needed by the other organs which are in constant use." Here Fisk foreshadowed in philosophy the research work of recent years in the necessity of considering the organism as a whole in the endeavor to determine the normality of any of its parts. Philosophically considered a normal individual organism is one expressing an adjustment of internal to external forces consistent with the most complete growth and development of the organism, as a whole. Certain organs develop and atrophy to maintain this equilibrium.

In studying the question of the individual normal it is of particular interest to note the change in the attitude of science to the problem of adaptation, and to follow the investigation in physiologic chemistry and heredity.

For several decades after Darwin the literature was filled with philosophical speculations relative to the phenomena of adaptation. Students of evolution found the study of it so much more interesting and impressive than that of specific diversity that they seem to have seen nothing else. However, during this period very little progress was made. And it was not until the introduction of experimentation on the basis of the quantitative method by the school of experimental biologists headed by Jacques Loeb that definite progress was made.

Approached from a new angle the problem of adaptation appears in a very different light. Loeb says "that authors have too often spoken of adaptation to environment where environment was not responsible for the phenomena."[5] And "while it is possible for forms with moderate disharmonies to survive, those with gross disharmonies can not exist and we are not reminded of their possible existence. As a consequence the cases of apparent adaptation prevail in nature."[6] In another place he says, "Those organisms live and develop that are free from the grosser type of disharmonies; the rest are doomed on account of a gross lack of harmony of the parts. Those latter we never see and this gives us the erroneous conception that harmony or design is the general character of living matter."[7] In his work "The Organism As a Whole" the evidence and references are clearly set forth from which the conclusions as to the lack of design in living nature are derived.

In the work upon the internal secretions physiologic chemistry is applying direct and penetrating methods to biological problems. Mathews says:

"The body is an organic whole, and these so-called organs of internal secretion are not unique, but the bones, muscles, skin, brain, and every part of the body are furnishing internal secretions necessary to the development and proper functioning of all the other organs of the body. Such a scheme to be complete must embrace every organ; only the barest beginning has been made in this study, so important, so necessary for the understanding of development and inheritance. The problems of development and inheritance can not be solved until these physiologic questions are answered."[8]

It is claimed to have been demonstrated that what has appeared as adaptation when unknown has turned out to be a result of the action of a definite chemical substance circulating in the blood. Leo Loeb observed that "the corpus luteum of the ovary gives off a substance to the blood which alters the tissues in the uterus in such a way that contact with any foreign body induces the same decidua formation as does the egg." Steinach has shown that "the wonderful mating instincts seem to be due to definite substances secreted by the sex glands."[9] Lewis has shown "that if the optic cup is transplanted under the skin of a young larva into any part of the body the skin in contact with the optic cup will form a lens; it looks as if a chemical substance from the optic cup were responsible for the formation of the lens."[10]

In the work of the mutationists and students of Mendelian heredity there is evidence that disharmonic conditions of development may express alterations in the hereditary constitution. In the *Scientific Monthly*, May, 1918, Morgan says:

"A specific gene may be essential to the normal development of a certain

organ, which organ through an internal secretion may affect other parts of the body, or even the body 'as a whole.' If, for example, the development of the thyroid gland were known to be dependent on the presence of a certain gene (amongst all of the others involved in its formation) a change in the postulated gene leading to the arrest in the development of the thyroid gland would, owing to the lack of a sufficient amount of some internal secretion of that gland, produce a malformed child with all of the various stigmata of the cretin."

If this is true then the factors of heredity can not be eliminated even though the phenomena directly responsible for the development of a deformity can be traced to the abnormal activity of a ductless gland.

It is neither necessary nor wise to accept in detail the conclusions of any one man or class of men in an attempt to establish a scientific truth In experimental biology it is never certain that all conditions are constant except the one being studied. Consequently it is quite a common circumstance for two investigators of ability to arrive at conclusions diametrically opposed. Furthermore, it is always difficult to determine the value of evidence and particularly so when the alleged phenomena are of exceptional significance. The criterion of science in its three phases, observation, comparison, and experimentation is not always applicable in the study of the life phenomena of the human organism. Hence, the best that we can do in many instances is to apply the "test of inconceivability" to the evidence presented; believing things when we must, but not before.

However, from the most conservative standpoint of accepted scientific thought the doctrines proclaimed in the early days of modern orthodontia are now known to be inadequate. The evidence of science is explicit that the masticatory apparatus is a dependent and living part of a living organism; that it is controlled in its growth and development by the same factors which control the growth and development of the organism as a whole, and that it is expressive of both physical and psychical phenomena. We can no longer assume that all individuals possess equal possibilities of development. "Studies in modern genetics are emphasizing the immense, the overwhelming importance of heredity, in both phylogeny and ontogeny." (Conklin.[11]) And it must be remembered that the directing and guiding factors of development are present in the organization of the germ cell, while environmental factors exercise a stimulating, inhibiting and modifying influence on development. Heredity fixes the possibilities of development; it sets bounds beyond which we can not pass. Nor can we assume the inherent tendency of all organisms to evolve a definite type, harmonious in design, in the face of evidence of natural disharmonic development and the possibility expressed upon good authority that such disharmonies may in rare instances be of the character of hereditary mutations.

The relative importance of heredity and environment is not the same in the development of man as in the development of the lower animals; environment plays a larger influence because of the longer period of development while heredity plays the same part as in the lower animals. Although most deformities are considered as the result of extrinsic, environmental forces the nature of the condition can not be known without taking heredity as well as environment

into consideration because the character of a response to stimuli is determined by the organism. The forms which structures take on are not the result of either environment or heredity working independently. Conklin says, "We do not inherit disease but the factor which determines whether one organ is susceptible to a disease while another is not, may be an inherited factor."[12] Form development is the result of the interaction of forces determined by heredity and environment. Hence the etiologic factor of malocclusion is that which affects the organization of the organism or modifies the stimuli of the environment sufficiently to disturb the equilibrium expressed in normal development. A certain mechanical influence which will bring about a modification in the structural formation of the dental arch of one individual will not necessarily bring about the same arch formation in another individual. In each case we are face to face with the individual element.

The problem of orthodontia is a complex one. Founded upon the law of occlusion and concerned with the development of the dental arch of the individual organism it involves the most fundamental problems of biology. A conception of orthodontia limited to the mechanical relations of tooth forms, while alluring in its simplicity and the promise of the absolute, will not withstand the crucial test of practical utility, since it ignores the essential vital activity of life phenomena.

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DISCUSSION ON THE PAPERS OF DOCTORS ALFRED P. ROGERS, A. LEROY JOHNSON, AND JOHN V. MERSHON.

Doctor Hugh K. Hatfield.—One of the most striking things about these three papers, it seems to me, is their completeness in sequence. Doctor Johnson emphasizes the fact that there is a normal for each individual, and that this may vary widely from the average or normal for the species or race, and that the ideal of a perfect arrangement of teeth to give absolute occlusal contact may or may not exist in this present day.

He makes it clear that the individual normal must be determined by a consideration of other factors than tooth form. He shows the importance of studying, not so much the models, as the case histories of each individual by every aid science possesses, realizing that in the complex interrelations which the body presents in such a function or organ, we are dealing with a set of processes entirely without parallel in the inorganic world. To still hold that a shoulder to shoulder arrangement of contact points and a more or less perfect interchange of stimulating force through the occlusal planes, is the sole maintaining force is folly. He urges a greater study of quantitative measures and a more comprehensive, intelligent and exact use of statistics that more light may be thrown on our subject. Some one has said that "nothing is fully known until it can be expressed mathematically." To mention one unknown quantity, do any of us know yet the relative frequency of this condition of malocclusion?

Doctor Rogers and Doctor Mershon have both presented extremely interesting forms of treatment. Doctor Rogers has demonstrated the manner in which a physiologic effort is made to bring out the development possible in each individual child, a better muscular tone, a very potent factor in maintaining built-up bony structures. This is the functional factor, the constructive agency in form development, but the inherited element in the organism must determine the possibilities of development.

Doctor Mershon has shown the simplest possible artificial means of stimulating and changing the alveolar structure in our effort to aid nature in development interfering in the least with physiologic activity of the parts.

Too much unpractical and unscientific theorizing in the clinical field has made our specialty top heavy, and to keep our foundations solid and commensurate with the superstructure, is one of our problems today.

Doctor Calvin S. Case.—Mr. President and Gentlemen of the American Society of Orthodontists: The very interesting paper by Doctor Johnson which I was to discuss before your society, has at last been placed in my hands.

I find upon a careful reading that it is a difficult paper to discuss, because there seems to be no definitely stated conclusion or proposition relative to the principles or practice of orthodontia. This leads me to fear that I will make a wrong interpretation of the essay in its discussion.

It is certainly interesting in the sense that it conclusively proves that the practice of orthodontia is the one branch of dentistry which leads investigating minds to realize the needs of a more or less familiar understanding of the principles of biology, and particularly the laws which remotely or otherwise have led to many dental and dento-facial malocclusions.

This subject (if I may be allowed to introduce a personal equation) was pretty thoroughly thrashed out in a paper and its discussion, entitled "The Question of Extraction in Orthodontia," read before the National Dental Association in 1911.

The practice of orthodontia also must lead to a higher appreciation and study of facial art, now that the possibilities and opportunities of correcting the facial outlines in deforming protrusions and retrusions have been greatly increased by the somewhat recent acceptance and practice of "bodily movement."

I have wondered if it were not the main object of the essayist to give a warning to those orthodontists who were still following the arbitrary cut and dried mathematical rules of practice, oblivious of individual demands. It is not strange in my opinion, that many orthodontic specialists at one time were permeated with misleading beliefs in regard to occlusion and malocclusion of the teeth, as the essayist has intimated, and of which it is not a far cry to say was because they were fed like birds with open mouths on a cir-

cumscribed quality of false pabulum, outside of which all other teachings were *verboten,*

It is refreshing to see such manifestations as the paper presents toward the awakening to broader knowledge founded upon established principles of scientific thought. While I can not quite see the practical application of the lengthy scientific and philosophic dissertation apparently to define the meaning of science and how it differs from common knowledge, and to prove that normal occlusion of human dentures arose like other grand and perfect anatomical culminations through the natural forces of nature, I have no doubt the essayist had a certain purpose in view which may be that he felt the need of showing that the laws and teachings of science should be regarded as a dependable foundation upon which we may fearlessly rely, and feel at liberty—though it may not be what we were taught—to open our eyes and look out on the world of other thought and other teaching, and if desired may take long and much-needed draughts from nature's fountains, abundantly supplied upon every hand from the pens of eminent interpreters.

I think he endeavors to show that the equilibriated occlusion of the human dentures, known as normal occlusion, is not the ideal occlusion which formed so large a part of the earlier writings and illustrations of orthodontists, any more than physical forms of the human race individually follow the type of the Apollo Belvedere, but that it differs within the limits of its standard as people differ. Moreover, I believe it is generally conceded by scientific men that the inherited standard of dental occlusion has come down to us essentially unchanged through the ages from the prehistoric men of the old stone age, and kept in line through the law of natural selection (survival of the fittest), and its perfect adaptation to needs.

Even as far back as the "second interglacial period," 200,000 to 350,000 years ago, the forms, number, and relative position of the teeth and their occlusion was essentially the same as the standard normal occlusion of today. And though in the earlier stages of that vast period the jaws were of a heavier type, and the bi-maxillary protrusive prehensile mouths, enhanced by chinless mandibles, showed their distant descent from their anthropoid progenitors, the occlusion of the buccal teeth, their alignment and arch form—even the canines which had thrown off nearly all their carnivorous characteristics—were all practically the same as today. I speak of this because the essayist infers that the normal occlusion of modern man differs from that of the prehistoric.

I am pleased to refer those who are interested in this department of science to a recently published work entitled "Men of the Old Stone Age," by Prof. Henry Fairfield Osborn of Columbia University and U. S. Geological Survey.

In our strife to produce the highest possibility of our specialty by the accomplishment of the greatest good to humanity, if we are to regard this normal occlusion as a scientific guide in orthodontic practice in the same sense that health is the scientific guide in the practice of medicine, I am loath to believe that the essayist or any one having the intelligence and higher sensibilities of humanity can wish us to exclude from our view the increasingly appalling number of dento-facial deformities which the attainment of a normal occlusion can not possibly correct, and which appeal to us upon every hand for succor which we can so easily give, and too, with it an occlusion that is equally useful and often with greater chance of permanency of retention.

Many of the most strongly marked dento-facial malocclusions have arisen through the same biological forces of heredity that characterize the normal and relatively harmonious, but unfortunately through unions of inharmonious types on the principle of hybridizing, and from other sources, closely related physical disharmonies are frequently stamped upon individuals whose psychologic influences mar their entire lines, and whose beautifying correction from an artistic standpoint demands changes which should not be held subservient to the "law" of an idealized normal occlusion.

Doctor Alfred P. Rogers.—Where it bears relation to Doctor Johnson's suggestions my paper might be considered as a discussion of his. However this may be, I should like to add another word. Doctor Johnson has treated his subject in a philosophical manner. I believe that there are few of his hearers who would be able to comprehend the absolute depth of his reasoning until they have had opportunity to make careful study of the text. It was my privilege to look over the paper a number of times on the train en route to Chicago, and at each reading I more clearly received the import of the deeper meanings of the various phases of the subject treated. The paper is fundamental, and in undertaking a re-education in orthodontia Doctor Johnson's paper and subsequent papers should receive careful attention.

Doctor M. N. Federspiel.—In regard to Doctor Roger's splendid paper on muscular training, I must say it is an inspiration to us all to go back and try to do better work. Muscular training has been practiced in medicine for some time in curing kyphosis, round shoulders, and pigeon breasts, and the results obtained from so-called gymnastics, particularly the end results, have been wonderful.

The science of orthodontia is an organic part of medicine. It can not be separated, and we have to understand the various sciences which enter into the treatment of applied biology.

I can not add anything to what Doctor Rogers has said except to compliment him, and if he does as well from now on in studying the new classification adopted at the last meeting as he has in muscular activity, I will take my hat off to him.

Doctor C. A. Hawley.—I am very glad I was not expected to discuss Dr. Johnson's paper because it is one that I surely would not care to say anything about in the way of a technical discussion without reading it very carefully.

It seems to me, we have had three of the best presentations I have ever listened to before this society, and they have been in natural sequence.

I will say in regard to all of the papers they have been by gentlemen in whom from long association we have the greatest confidence, men who are conservative and essentially students of science, and to whom we can listen with the greatest confidence.

Doctor Rogers' paper opened a field that we have conceived was there, but we have not had the genius that he has had to develop it. We have talked for a long time about the primary causes of malocclusion, lack of function, and so on, and yet we have not really conceived the method of correction as it seems to me Doctor Rogers has done. Of course, in regard to just how far patients will go, and how much they can do, we who have not tried it are ignorant, but it offers the most hopeful prospect of anything to which I have listened. I heard a similar paper by Doctor Rogers some time in April, and talked over the matter with him personally, and I can relate to you what little experience I have had.

I went home and took two cases which probably are typical of those we often meet with in our practice, cases in which I had succeeded in obtaining practically normal adjustment and arch form, but in which the mesio-distal position relation was not normal. I used intermaxillary ligatures again and again but was unable to permanently restore the position of the jaws. I went home and sat down and talked to these patients and explained to them that I had done everything that I knew how to do, and said now the question was for them, and I tried to give them as nearly as I could these exercises. One boy I had worked on for a long time, and I got the occlusion established again and again, and yet while the position of the teeth would allow his biting forward in the proper position, in a short time the muscles would relax, and he would come in with the lower jaw hanging just as bad as ever. He was a boy of intelligence and understood the problem and went to work at it, and in two months time he himself made more improvement than I had ever been able to do before. I am greatly encouraged, and I believe from this experience I can thoroughly endorse Doctor Rogers' treatment.

Here is a phase of the subject that strikes me as very important: Patients are apt to come to us with the attitude, "I have malocclusion; I have this condition, and you are to do the work." Doctor Rogers places a different aspect on the question. He says I can do so much, but you have got your part to do. It is a co-operative procedure. I think that is a very important thing, and I never realized until I heard Doctor Rogers' paper the importance of it. It seems to me, that the extension of this work is going to do more to put orthodontia on the proper basis than any aspect of the work that has ever been presented.

In regard to Doctor Mershon's paper, the writer devotes the introduction of his paper to a discussion of the functional activities of teeth and associated organs during the progress of orthodontic operations. I heartily agree with his statements. In a broad way, it is generally agreed that malocclusion of the teeth is the result of lack of their use in childhood, especially in the period from the completion of the deciduous denture to the time when the first permanent molar is erupted and the deciduous teeth begin to be lost. The habits of mastication and the development of the muscles concerned with it are mainly formed during this period. How important then it becomes that these habits be not obstructed or lost by the interference of orthodontic appliances, and that the health of the surrounding tissues be maintained as well as the natural movement of the lips, tongue and cheeks. In this connection, contrast the simple appliance the author describes, with the old sixteen gauge labial arch having the usual number of bands and wire ligatures or

the later pin and tube appliance or even the ribbon arch with its necessary bands and brackets. The one leaves practically free the function of the individual teeth as well as the cheeks and lips, and others practically destroy them all. In the hygiene of the mouth the contrast is equally marked. As efficiency is the first requirement of an appliance it will naturally first be asked "Can the work be done with so simple an appliance?" The paper of the essayist is a competent answer.

As to the technical part of the paper, there are a few points that I might mention, not however of great importance. While in the majority of cases straightening the bends and kinks of the wire will produce sufficient length, if needed a small amount can be gained by making each bend at the compound bend in front of the molar pin, a right angle bend, then later making them obtuse. A small loop can also be made at a favorable place and later straightened, if thought necessary, or the wire may be cut and a piece taken out or put in. In any such manipulations, however, the greatest care must be taken not to disturb the relations of the pins to the tubes on the molar.

My own favorite size of wire is .035 or 19 gauge. However, some of my best results have been obtained with .030 and I have used some .028 with good results. Greater changes can be made at one time with the smaller wire, but at the same time the stability of the arch form is not so great, and it is more likely to be bent by the force of mastication. It is also not so favorable for the attachment of auxiliary springs.

I find heat treatment valuable in restoring the temper of the arch, especially after attaching auxiliary springs. The arch is heated to redness preferably in an enclosed receptacle, and then cooled slowly in the air.

The essayist has wisely cautioned against too much change at one sitting. As I look back at my first experiences I am satisfied that this was one of my prominent faults. A beginner will naturally ask, "How much change can be made in one sitting?" While this is very hard to answer, yet of one thing we can be sure, an arch should never be changed so much that it will not snap back to place and retain its position. It must be remembered that we are depending in the use of this appliance considerably on the force also exerted by the natural function of the teeth.

There should be great caution concerning the changes made in the pins attached to the molar teeth, especially in using the heavier arch. If care is taken in the impression and model, there should be no soreness after the first adjustment, but any subsquent adjustment that disturbs the relation of the pins with the tube, places strain on the molars.

In my experience it is not desirable to leave the arches without some fastening to other teeth than the molars. They may go along for months without accident, then by the use of sticky candy or lifting with the fingers to relieve some slight irritation, the arch may be bent and lifted from place. I first banded some convenient tooth and placed a short lug for the arch to rest under to avoid this accident, but later have made use of what I call a loop ligature. (Fig. A.)

The ligature may be of gold or the usual composition wire and unless rotation is necessary, answers every purpose in securing stability of the arch.

In some cases additional root movement may be desired in the incisor region. While this movement is not necessary so often, as in the use of labial appliances, owing to the free action of the lips, yet in many cases I have preferred to make this movement definitely in as short a time as possible. For this purpose I have used the old labial loop of light spring wire, .022 attached to the lingual wire just distal to the cuspids and coming through this opening which is present even in the most perfectly occluded denture. With the lingual arch resting closely against the teeth at the gingival border and the labial loop wire passing close to the incisal edge, root movement can be easily and quickly obtained. Considerable rotation can also be obtained with this wire. (Fig. B.)

I also use the Lourie arch. The essayist mentioned the fact that the lingual arch may be continued as a retainer and rightly considers it valuable for this purpose. It still, however, has the objectionable feature of the molar bands.

To obviate this danger I have been using for the past year a form of retention which developed from the McBride retainer, which I showed before the society about ten years ago at the Detroit meeting. This retainer consists of a skeleton plate of gold or vulcanite with wire anchored in the plate and passing to the labial side at the distal surface of the cuspids with clasps over the bicuspids. The wire as far as the forward portion of the loop, is made of 19 gauge clasp gold and the labial portion of ribbon arch wire. (Fig. C.) If the plate portion is made of gold, it should be cast as it must absolutely fit the lingual surface of the teeth. The principle is that a tooth to rotate must raise away

from the plate and the close fitting labial wire prevents this movement. If such a movement does start, slightly tighten the labial wire so that it will press harder on this tooth on the corner that is moving and it will quickly bring it back to place. After wearing the retaining plate continually for three or four months, I have found it sufficient if it is worn only at night. It will not, however, retain the rotation of small round-shaped lateral incisors nor lower bicuspids.

I have been working on this appliance for the last ten years, but have at last reached this form and I hope it will be successful. I am speaking of it at this time in view of its value in connection with these three papers. In the first place, there are no

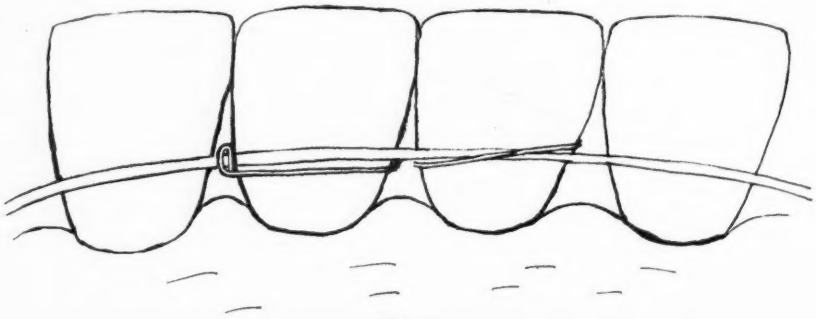

Fig. A.

Fig. B.

Fig. C.

bands upon the teeth. In the second place, after being worn a short time it can be removed during the day time and worn only at night. That makes cleansing of the teeth perfect and makes the use of muscle exercises much easier.

During the last six months I have placed something like over sixty of them in the mouth, and I have not yet had a serious failure, but I may have a big bunch of trouble next year. I do not know.

Considering the whole scheme of treatment, as outlined by the essayist, and which no doubt is susceptible of still greater development, it offers for our study and effort a treatment with which reasonable prophylaxis is possible and easy, a method in which the

teeth are reasonably free from the use of disfiguring and irritating bands and where the tooth brush and floss silk can be freely used and, most important perhaps of all, where the function of the lips and teeth are very little interfered with.

There was one point further I would like to mention, and that is, Doctor Mershon spoke of the time that elapses between the times of treatment. That becomes reasonable and easy because it is unnecessary to hurry treatment with this simple appliance. Many of these cases are treated without a single band on the anterior part of the mouth. Where the teeth are all tied up with bands and brackets, you want to hurry and get these things off as quickly as you can.

Doctor J. A. Burrill.—I have not had the opportunity to read any of these papers before they were read today, so I am not in a position to discuss them carefully. I am down to discuss the lingual arch, however, and I have this to say. Doctor Mershon's treatment is so much like some of my own, judging from his description that it is hard to add anything to it. If there is any place in which I can criticize his removable lingual arch it is the numerous springs. In my experience I have found that with a removable lingual arch, with two or three auxiliary finger springs as he calls them, there is too great a lack of stability and consequent irritation of the gum. It has been my observation that I can get along with less irritation of the gum by using bands instead of so many finger springs. However, I have had a good deal of success with the removable lingual arch in the way of general expansion, and after obtaining the general expansion to stabilize my lingual arch, I have added a labial bar which is parallel to the lingual arch, which lies in contact with the labial surfaces of incisors or incisors and cuspids as the case may require. This labial bar is attached to lingual arch by means of two short loops which lie in the

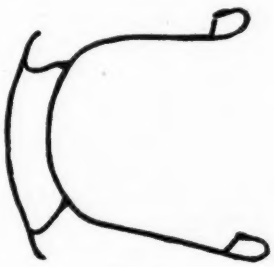

Fig. D.

incisal notch between the laterals and cuspids. These parallel bars are sufficient in some cases to rotate and retain incisors in torsal occlusion. (Fig. D.)

This appliance is also useful in depressing the incisors and lifting the anchor teeth in opening a long overbite. It is much more applicable however to the lower dental arch than to the upper. The drawing shows the manner of attachment of this labial bar as well as the manner of clasp I have used a great deal for attachment to the anchor bands. I have this to say, however, that I am gradually giving way to the soldered lingual arch and wire stretchers for such cases of expansion and I think I am getting better results.

Judging from the questions that were asked Doctor Mershon, I was led to feel that some of you were criticizing him for the length of time he took in accomplishing what he did in the particular case where it required one year. I feel that the extra time spent in carefully and slowly working these teeth into position shortens the necessary time for retention when that period comes, and as he said to us, the lingual arch is often all the retention that is necessary.

I feel that I can not help but refer in the matter of retention to the papers of Doctors Johnson and Rogers, and emphasize how necessary along with the active forces of occlusion are the normal muscular forces that have so much to do with the permanency of our results.

Doctor Milton T. Watson.—I have been much interested in all of these papers, and delighted to see that our problems are being approached from so many different angles. It is a hopeful sign.

I have a suggestion to offer in regard to the auxiliary springs Doctor Mershon spoke of. By using a wire drawn to two different gauges, it is possible to solder the heavier, or base end, without injuring the temper in the thinner portion; the result being a very

delicate, but extremely active, spring. These springs are made by taking a short piece of wire, which has already been drawn to the proper gauge for the base, or heavier, end of the spring, and putting it through the next smaller hole in the draw plate, but stopping while there is still approximately a quarter of an inch of wire of the heavier gauge. The wire, of course, has to be withdrawn from the draw plate backwards. Springs made in this way have proved much more satisfactory in my hands than where wire of the same gauge is used throughout the entire length of the spring. Retempering is, of course, unnecessary.

Doctor Ralph Waldron.—It has been my pleasure at the invitation of Doctor Mershon to go to Philadelphia and see him work, and the only comment I have to make upon Doctor Mershon's paper is, he has been too modest in his claims for this appliance.

I have experimented a great deal with the material used by Dr. Mershon, namely, platinum-gold alloy, and find it to be a most admirable material to work with, for it can be annealed and tempered as often as required without the loss of any of these properties.

If you will take a piece of No. 4 wire (Aderer) or E wire (Ney & Co.), and place it on a copper pan which is about 14 gauge (B & S) and heat the copper pan to a bright red heat, then plunge the wire into cold water. This will anneal the wire so it will become soft enough to tie in a knot without breaking. Now if you will put this wire on the copper pan again and heat it as before until it becomes a bright red color, then allow the pan and its contents to cool in the air, all the original spring temper this wire possessed will be restored.

Some member has asked how it is possible to get the spring effect in the finger which has been soldered to the base wire.

The base wire is 19 gauge or about .037 of an inch in thickness. The finger spring is only .022 of an inch in thickness and after soldering with 18 or 20 karat solder, and upon cooling in the air becomes springy again. Now bending the finger spring to the desired shape adds a little more spring quality to the finger, this is sufficient for all the force needed to move individual teeth.

Doctor Robinson.—Does this restore the temper given to it by the draw plate after it has been heated?

Doctor Waldron.—You can restore the original temper exactly the same as when it left the manufacturer, because the manufacturer anneals and tempers this wire after it leaves the draw plate, and before it is sold to us for our use.

Doctor Robinson.—I would like to get the formula of the wire.

Doctor Waldron.—I do not know the exact formula, but the No. 4 wire is far superior to the other wire manufactured by Mr. Aderer, and he informed me that the No. 4 contains; Au, 84 parts, Pt, 23 and 8-10 parts, and Cu and Ag, 35 parts.

Doctor Robinson.—I have never seen a wire that could be heated in any way to give any such temper as it has when it comes from the draw plate.

Doctor Waldron.—I would like to ask Doctor Mershon if he has not found that he can get all the spring he wants in the finger wire by allowing it to cool down in the air after soldering.

Doctor Mershon.—By allowing it to cool down and bending the wire you may not get the same temper you had in it originally, but I can say in all cases it is sufficient.

Doctor R. Ottolengui.—I did not really intend to contribute to this discussion, but I am tempted to say something in reply to Doctor Hawley. Doctor Hawley in speaking of his retaining plates, said they must be cast, because they must fit accurately to the lingual surfaces of the teeth.

I have had a very considerable and very unpleasant experience with cast gold plates. Plates that are cast are necessarily heavily alloyed with low grade metal. That may be one of the reasons for the trouble that I have observed. Another possible reason is that in casting these plates the surface comes out granular, and in our desire to get an actual fit to the surface which comes in contact with the gum, the plate is not really polished. The granules are not removed. Whether it is a chemical disturbance or a traumatic disturbance due to the granular surface I do not know; but you can not put one of these plates in an adult mouth and leave it a year without having a chronic inflammation of the mucous membrane. That can all be done away with, and Doctor Hawley's wishes can be fully met, so far as perfection of fit is concerned, by making accurate models, and accurate dies. Then swage a plate of 36 gauge pure gold; then with

another set of dies swage another plate of 20 carat gold, and then sweat two pieces together. You have a smooth, polished gold surface against the rough mouth; you have a fit; you do not have the inflammation you get from the other styles of plate, and the plate is just as rigid as if made by the casting process.

Doctor Frederick C. Kemple.—The presentation of these three papers this afternoon offers a very interesting study in the evolution of the practice of orthodontia. It seems that we are getting to fundamental principles; we are getting away from complicated methods. We are getting away from the idea that we can take the mouth of a patient and mould it into any form we choose in spite of physiology or function or anything else.

The paper presented by Doctor Johnson is one that ought to be read and re-read and studied before it can be fully understood and appreciated by most of us who are practicing orthodontia. It gives an exceedingly broad view of the fundamentals of orthodontia.

I agree entirely with Doctor Rogers in regard to the efficacy of muscular development. There is no question that if these muscles are toned up they will aid materially in restoring natural function. The difficulty as I see it lies in securing the cooperation of the patient to the degree sufficient to develop the muscles of mastication to the normal tone. And with the presentation of the lingual arch and the little finger springs allowing individual tooth movement. I think it is a most hopeful sign. The very extreme enthusiasm that greeted the introduction of the pin and tube appliance seemed to me a backward step in orthodontia. It seemed to be getting away from natural function.

The presentation of these papers this afternoon may mark another era in orthodontia. I know that some of these essayists were very enthusiastic users of the pin and tube appliance, and now they are getting back to the point of preaching and teaching freedom of individual tooth movement in all of this work. It is very gratifying indeed.

Doctor V. H. E. Jackson.—I am interested in seeing how we are working towards the finish, and I am glad to see we are getting through different forms of springs, and it is nice for people who have made them to see what results you get, and I hope you will keep it up until you master it. There is no doubt about the value of these springs. I am very enthusiastic over the spring force; I have had a good deal of experience with the lingual spring and the labial spring. I prefer the lingual spring for the general expansion of the arch when it can be used to advantage, and I see you are using it to advantage.

I am very much pleased at the exposition we have had here today, and I shall be interested still more in seeing how we work tomorrow. I am gratified to see what the boys are doing and anything I can do to help the spring will be gladly done.

Doctor A. Leroy Johnson.—(closing on his part): I have nothing to add to the discussion, but I would like to take this opportunity to thank you for the privilege of attending this meeting of the American Society of Orthodontists. I am enjoying it immensely.

Doctor Alfred P. Rogers.—(closing on his part): It is pleasing to me that the arrangement which the Board of Censors was kind enough to make in having Doctor Johnson's, Doctor Mershon's and my paper read in succession has worked out so nicely. I think it was Doctor Johnson's suggestion that they be arranged in this order. I, therefore, think that the Society should give credit to Doctor Johnson.

Doctor John V. Mershon.—I have nothing to say in closing the discussion on my paper, except that I regret Doctor Burrill did not receive a copy of it to read before he began his discussion. It was mailed to him, and it was returned to me in Philadelphia, and I received a wire to this effect up in Maine where I was spending the summer, that a copy of my paper was returned to my office.

Doctor Burrill spoke of the great number of springs I am using. It would appear that I use auxiliary springs almost exclusively, which is not the case. I showed a great number today to demonstrate the various movements which can be produced by the use of those springs.

TEACHING OF ORTHODONTIA TO UNDERGRADUATES*

By Ralph Waldron, D.D.S., Newark, N. J.
Professor of Orthodontia, New York College of Dentistry.

THE beginning of orthodontia, like many other sciences dates back into the obscure past, and was subsequently practiced by those who were totally ignorant of the physiologic functions of the teeth.

They knew teeth moved and changed their respective positions, but they never considered such things as the etiologic factors which caused deviation from the normal, like Topsy, "They knew they just grew that way," and we are not surprised when we find as late as 1897 one of the leading textbooks on this subject contains but four pages on etiology.†

The principal thing that attracted the attention of the dentist, was the ugliness of the case at hand, and in his endeavor to better the appearance of the patient he extracted teeth or made some mechanical device which naturally was very crude and usually clumsy, and I am very sorry to have to admit this condition exists to a limited degree to this day.

The making of orthodontic appliances used to be considered as mechanical dentistry, and was taught by the professor of prosthetic dentistry, who lectured upon this subject, not because he was unusually skilled in the science of orthodontics through practice, but because he could not pass it over to some other member of the faculty.

Luckily, for all concerned, orthodontia became a distinct science, founded upon definite principles, with a diagnosis, and a well-defined line of treatment, with a rational prognosis, through the energies and studious thought of men like Doctor E. H. Angle, and many others who need no introduction to this society.

These men labored long and hard, that orthodontics should not only survive but should be classed as a true science founded upon biological principles and not merely a mechanical art.

Within the last few years our universities have become thoroughly convinced that orthodontia is a distinct and separate branch of dentistry, and have created a chair of orthodontics with a professor who devotes his time exclusively to the practice of orthodontia, and who has a separate staff of instructors in this science whose duty it is to instruct the students and supervise their ever increasing clinics.

No man can sincerely dispute the fact that the study of orthodontics is a postgraduate work if it is to be brought to the ideal, but this is not always possible, for the general practitioner of dentistry must undertake many of the cases which develop in his practice, especially if his practice is in a district far remote from a locality which can support an orthodontic specialist.

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*Read before the Eighteenth Annual Meeting of the American Society of Orthodontists, Chicago, Ill., August 1-3, 1918.

†Kirk's Operative Dentistry (1897 edition).

The department of education in our various states, realizes this and some have laid down a minimum course of study for all dental schools, seeking to be registered by the state board of dental examiners within their respective states, and naturally the colleges wishing to be credited in the various states live up to these minimum requirements and some greatly exceed them.

The Board of Regents of the state of New York have set the following as the minimum of orthodontic requirements they will accept from colleges seeking recognition, in order that their students may take the licensing examinations of the state of New York and be entitled to practice dentistry within that state.

The following is the minimum course accepted by the Board of Regents of the state of New York:

FOR THE THIRD YEAR

Fifteen hours of recitation and lectures on orthodontics.

Fifteen hours of laboratory work on orthodontics. Seven and one-half hours credited time.

Actual time, thirty hours.

Credited time, twenty-two and one-half hours.

FOR THE FOURTH YEAR

Fifteen hours lecture and recitation on orthodontics.

Sixty hours laboratory work.

Actual time, seventy-five hours.

Credited time, forty-five hours.

The lectures to be upon the following topics for three or four years: Historical sketch; consideration of former methods; technic of wire drawing, soldering, etc.; nomenclature and definitions; normal occlusion; forces governing normal occlusion; transition from deciduous to permanent denture; malocclusion; forces governing malocclusion; classification of malocclusion (Angle); etiology; benefits in correction of malocclusion; importance of the first permanent molar as a key to occlusion; the sizes, forms, interdigitating surfaces, and position of teeth in the arches; the line of occlusion; facial harmony and balance; process and membrane, including tissue changes incident to tooth movement; dentofacial orthopedia; consideration of instruments; anchorage and dynamics; adjustment of appliances; impression and casts; treatment of Class I; treatment of Class II; treatment of Class III; principles of retention by classes; care of the mouth and office records and management of cases.

We have now arrived at an era of dental teaching when the various branches, distinct though they may be, must be so correlated and interwoven in their presentation to the student, as to make the entire subject a complete presentation.

The interdependence of the various subjects must be more and more forcefully placed before him. For example, the technic of wire drawing, annealing and tempering of orthodontic metals and alloys are taught by the professor of chemistry and metallurgy; anatomy of the mouth and teeth are not taught by the professor of orthodontia alone, but also in the departments of anatomy,

dental anatomy and operative dentistry, two years before he studies orthodontia.

The alveolar process and peridental membrane can be better taught in the department of histology, while diseases of the mouth are taught by the professor of that subject and touched upon by almost every member of the faculty, whenever it bears upon his work. The technic of soldering is taught in the prosthetic dental department and the student does this continually more or less the first and second year of his college course, so when the student has reached the third and fourth year his mind has been so trained and he has become so skilled in technic that he is in a receptive condition to absorb orthodontia and the correlated dental subjects. In other words, the so-called nondental subjects, as anatomy, physiology, metallurgy, chemistry, bacteriology, histology, pathology and physics, also prosthetic and operative technic should have been completed before he is allowed to continue into the third and fourth year and by this method the student will be better fitted to learn and practice orthodontia and dentistry.

The plan which has been approved of by the faculty of the New York College of Dentistry for the course of orthodontia is as follows:

Thirty hours of lectures in the third year.

Thirty-six hours of laboratory work, which is more than twice the amount demanded by the Regents.

The laboratory work is as follows:

1. Impression-taking and model-making of orthodontic study models.
2. The construction and application of two Angle expansion arches, using Mershon's method of band construction and adaptation, and cementing same to models.
3. Construction of Mershon lingual removable arch, on upper and lower.
4. Construction of Ainsworth arch with bands on molars and bicuspids.
5. Construction of Angle pin and tube appliance, with Young-Angle latch lock on upper.
6. Lingual arch on the lower with fingers as is advocated by Dr. Lourie.

The lecture course for the third year consists of thirty lectures, one hour each week, for a period of thirty weeks, upon the following topics:

1. Preliminary outline of the subject of orthodontia.
2. The literature of orthodontia.
3. First principles. (Scope.)
4. History.
5. Nomenclature.
6. Development of dental arches.
7. Normal occlusion and the forces which govern the same.
8. Distinction between occlusion and articulation.
9. The transition from the deciduous to the permanent denture.
10. Malocclusion of teeth.
11. Malrelation of arches.
12. Classification according to Angle and Lischer terminology.
13. The attachment of the teeth.

14. Tissue changes caused by mechanical stimulus, or tooth movement.
15. Harmony and face form.
16. General outline of anomalies.
17. Etiology.
18. The alveolus and peridental membrane, from an orthodontic viewpoint.
19. Impression, models and plaster technic.
20. Duplicating orthodontic models.
21. Photographs and records; their value and uses.
22. Uses of x-ray in orthodontia.
23. Soldering and band technic.

FOURTH OR SENIOR YEAR

Fifty-four hours of practical work in the clinic upon patients.

Three hours (nine to twelve), one day each week, for a period of eighteen weeks.

This is absolutely imperative and no man will be graduated who fails to live up to these requirements.

The lecture course for the fourth year is as follows:

1. Preparation of the mouth for orthodontic treatment.
2. Records of treatment.
3. Diagnosis.
4. Arch predetermination. Hawley, Stanton, Hanau and Sved.
5. Dento-facial deformities.
6. Prognosis of oral deformities.
7. Anchorage.
8. The evolution in methods of treatment.
9. Dynamics.
10. Application and construction of fixed appliances, of all types, for orthodontic purposes.
11. Treatment of malposition.
12. Treatment of simple neutroclusion
13. Treatment of complex neutroclusion } Class I. Angle.
14. Treatment of simple distoclusion
15. Treatment of complex distoclusion } Class II. Angle.
16. Treatment of mesioclusion Class III. Angle.
17. Treatment of unilateral mesio-distoclusion Class IV. Pullen.
18. The surgical treatment of extreme jaw malformations.
19. Retention of all kinds.
20. The problem of extraction or the "compromise treatment."
21. Jackson and other removable appliances.
22. Care of the mouth during orthodontic treatment.

This course was not formulated to educate specialists, but to give the undergraduate the necessary ground work for his after-study and development, for no college can expect to turn out a finished product. It is time and experience, which are the parents of such a child, but the graduate dentist must know

enough about orthodontia to recognize malocclusion in its incipiency and be able to properly advise parents what course they should pursue, and save the child the necessity of prolonged treatment by early and skillful diagnosis.

DISCUSSION

Dr. F. M. Casto.—The subject of this paper I think is most opportune. At the present time, there is a great revolution taking place in dental and medical education. You probably all know that there has been established in the Surgeon General's office of the War Department a dental and medical educational department. It is the purpose of this department to standardize dental and medical education. They have the opportunity to do this because they have practically direct control of these institutions. It probably would not be possible to bring about the tremendous changes in the curricula and in the requirements of these educational institutions; it would not be possible under any other conditions than those that are existing today. You probably all know that these institutions are kept alive by virtue of the government permitting men to enlist in the Enlisted Reserve Corps of the Medical Department, and then they are placed on a negative status until their courses are completed. They have direct control not only over the requirements of the educational institutions, but over the requirements of the individual student in these institutions. The man who is not promoted with his class, and does not meet the requirements, will not be allowed to remain in school. He will be taken immediately, when he fails of promotion into active service in the army as a private. They are now working in cooperation with the Dental Educational Council of America (that is, the War Department) and have established a classification of schools. They have placed dental and medical schools in Classes A, B and C. Class A schools meet certain requirements; Class B schools may be able to meet the first requirements, and Class C schools are schools that can not meet the requirements of Class A or Class B schools without reorganization. They do not recognize Class C schools. Therefore, all students in Class C schools in the draft age will not be allowed to remain. Any man in a Class C school is subject to draft and will be called; therefore, a Class C school can not remain in business except for those who are not eligible for the army. You can readily see what that means. Those of you who are familiar with the evolution of dental and medical education probably know the great difficulties and great problems which have been experienced in bringing about higher requirements. It has been a very difficult task.

In regard to the branch of orthodontia, there is a requirement in the Class A school for teaching a certain amount of orthodontia. You will all agree I think that the proper teaching of orthodontia is fundamental to the welfare of the future dentist, and especially to the welfare of the future progress of orthodontia, because the men who are to succeed the present quota in orthodontia are those who are naturally going through the dental schools.

Another reason why it should be properly taught is that with practically all state boards throughout the country orthodontia is made a requirement just the same as is any other of the branches. I might say for your information in regard to the requirements in a Class A school the number of hours that are required now are approximately 4500 hours of teaching to the students in the four year course. That means about an average of 1100 hours a year. Probably some of the older members of the society, including myself, had a third of that number of hours.

In regard to the work which Dr. Waldron has outlined and scheduled in his school, I wish to commend it. I concur in what he has said and the manner in which he is teaching. The work I have been doing personally has not been up to the present time conformable to all the work that he has laid out. It has been impossible to do that, but I expect next year, and as soon as we are on a complete four year course, to install practically the same amount of teaching that he is giving. You all realize that in a college giving a three to four year course it complicates things considerably. For instance, this coming year we will have in our school no junior class. Next year we will have no senior class. There is a great clinical proposition to take care of, and the teaching of these men in the sophomore class now and sophomore class to follow will be different when the complete four year schedule is installed.

One of the greatest difficulties I have found in the real teaching of orthodontia is the clinical proposition. You all realize that in a dental school it is naturally difficult. The reasons are obvious, but we have attempted and will attempt further next year to have

a certain number of practical cases that may be handled partially at least by the students themselves. We have installed for the coming year a man who will take charge of the orthodontic and the periodontic department, and we feel we shall be able to get better results than we have heretofore. The students are quite enthusiastic about orthodontia until they get cases, then they lose their interest.

Doctor John V. Mershon.—I am very sorry that I am to discuss Doctor Waldron's paper. It is very difficult to talk on a subject about which one knows so little. I have occupied a teaching position for the last two years, before then I thought I knew more about teaching than I do today.

The teachers of orthodontia in the undergraduate schools are between two fires. On one hand you have as the essayist has outlined, a fixed requirement which is laid down by various states. On the other hand, you have another condition, the state boards, which are asking questions ranging all the way from jackscrews to still voting for Andrew Jackson. After you have employed enough time to meet all these requirements you can then start to do the teaching. I do not blame state boards, in fact I have the greatest of sympathy for them; they have a very difficult task. For if in a meeting such as we are having at this session, discussing various subjects as we have, with the differences of opinion we hear from the men who are specializing in this department, differing quite radically from each other, how can we expect men on state boards to keep up with it?

How can you lay down fixed rules for a progressive science in which our ideas of next year are different from what they are today?

As for the clinical side of the course in the undergraduate schools, I question very much its value as a teaching method. We should but consider that the treatment of a case of malocclusion covers anywhere from four to six years, sometimes the life of a patient, you might say. Students will have patients probably through one session, or part of two sessions, seeing the patient a little while in the winter season up until May, when they have to discontinue their cases because they are studying for examinations. These cases are left until the following October or November without any attention, unless the school is carried over in the summer and has a corps of assistants to carry these cases over the summer, and this does not teach the student. In some of the large schools such as Doctor Waldron takes care of in New York City, where they have enormous clinics, this is a difficult problem, to say nothing of the injustice to the children coming to these clinics under these conditions.

How can we as teachers in a school where the men have to absorb operative dentistry, root canal work, and everything else pertaining to the whole curriculum in the dental schools expect the students to become proficient in the practice of orthodontia with their limited opportunity?

Practice can only be acquired through long experience, and I think it is a waste of time to undertake to teach the practice of orthodontia in an undergraduate school. I think the most of our time and energy should be devoted to the teaching of principles of, and etiology of, malocclusion and the possibilities of failure, and it should be taught as a department of biology and pathology.

Dr. B. E. Lischer.—In addition to a feeling of reserve on educational matters, I have had no opportunity to read the paper, and hence can only express myself very briefly on the subject of dental education. I note that Dr. Waldron limits the title of his paper to "The Teaching of Orthodontia to Undergraduates," for which I am deeply grateful.

This entire discussion, it seems to me, might be very logically divided into the immediate and ultimate. By immediate, I mean the present provisions in orthodontic education, and by ultimate, its final status.

It is an established fact, and it is becoming very widely known, that oral deformities are of very common occurrence. Fully fifty per cent of the children of every community are undoubtedly affected by them. The number of individuals that a practitioner of dentistry, or a specialist for that matter, can adequately serve is very limited; so much so, that no community at present is receiving the necessary orthodontic service. It is one of the duties of the profession to assist in providing this service in as efficient a manner as the circumstances will permit. Unfortunately, though society itself must provide, in part at least, the circumstances which make for thoroughness, it has not done so up to the present time. That undergraduates should receive instruction in the principles and methods of orthodontics permits of no arguments. Whether the time usually allotted to the subject permits of anything more than a mere superficial acquaintance with its contents is open to debate. I am yearly becoming more thoroughly convinced that the entire

dental educational system of today is inconsistent. Dentistry, including orthodontics, is a department of medicine and surgery. The advances of science have demonstrated this finally. The dental curriculum must therefore be recast to be in harmony with the best science of today. In other words, stomatology should be taught thoroughly in every medical institution. To do this, it will probably be necessary to reform the entire medical curriculum also. This must be the ultimate goal of all our efforts in educational matters. Any change of plan that does not keep in view the supreme end is a temporary compromise. Most dental educational reforms have thus far ignored this fact.

Dr. M. N. Federspiel.—I have come to believe that the entire teaching curriculum in dentistry is wrong, and I believe it would be a good thing if we closed the doors of every dental school in the United States and asked the dental profession to rap at the doors of the medical profession and ask for admittance. Think of it. Today in our profession we are trying to teach a smattering of medicine, and we still try to be allied to or associated with medicine.

I believe the time will come when we shall do less dentistry but better dentistry. The average crowns, ill-fitting crowns, and average bridges put in the mouths of patients today harbor pathogenic germs and are contributary factors in producing more diseases for doctors to treat. We are operating paths that are feeders of the medical profession. That seems to be a strong statement.

I do not think it is fair to let any dental student treat any orthodontic case at any time while he is a student of the school. I could not consistently ask a dental student in my oral surgery work to do a cleft palate operation, to do a resection of the jaw, or to remove carcinomatous tissue. He is trained to know that medicine is nothing more than applied biology. He is trained to know that he must be able to make a diagnosis and a differential diagnosis. He is trained to know what biology is and what it means, and he is trained to know that treatment completes diagnosis and prognosis. Treatment is not complete until he knows something about diagnosis and prognosis.

After this great war is over, the average man who entered the Dental Reserve Corps will be an oral surgeon. That is a natural sequence. Everybody is going to be an oral surgeon. All he has to do is to take a knife in hand, draw a little blood, and he is an oral surgeon. (Laughter.) He buys a few curettes, wears a white gown, may have his operating room carpeted, and pretty shades on his windows; he may look the part of a doctor, he may make an incision in the gum, curette, scrape, and poke around with gauze; but when you ask him to note the tissue changes that have taken place and what takes place in the healing of wounds, he is lost. He can not tell the abnormal from the normal tissue when he uses the knife. He has not been trained in etiology; he has not been trained in histopathology.

The time is coming when we are going to have more group diagnoses; the one-man diagnosis will pass out of existence. You can not go to work and become so proficient and finally practice orthodontia as a specialist without getting the aid of others in certain cases. We must have group diagnosis, and that is the ultimate goal of the art of medicine. So I believe that orthodontia can not be practiced as successfully unless you have the cooperation of men around you. When, as Doctor Mershon says, a patient has to be treated for six or ten years, there must be something wrong. I do not like this perpetual treatment of patients. In my estimation, the ultimate goal of the science of dentistry will be a part of medicine; that every man must have the same entrance requirements that the physician has, namely, a bachelor of science degree. Dentistry will then become a specialty of medicine the same as ophthalmology, rhinology, surgery, or genitourinary diseases and so on.

Dr. William C. Fisher.—My remarks before this society are not to be considered purely from the standpoint of a student, yet I am still a student. I am not a teacher of orthodontia, but as a student of orthodontia I have naturally followed the teaching of orthodontia, and I think there are one or two points that have not been touched in any discussion, not only here today but in the past nine or ten years in this society.

As a guest of the society, I am going to try to tell you one of your shortcomings. I do not think you men have measured up to your responsibility in the teaching of orthodontia. When I took up orthodontia ten years ago I could not find what I considered (and that is no reflection on the Angle or the Dewey course) a high grade postgraduate course in orthodontia in America, and in desperation I turned to you gentlemen and your annual meetings, and it has been my postgraduate course, and I hope to make it a never ending one. But it does seem to me in the ten years I have been so cordially associated

with you that this society should have established, not a committee on nomenclature, although you established a good one, and this was done only recently, not a committee to consider this or that educational subject, but a council on education along orthodontic lines. You have the men in your society; they have the brains. There are no men on the Council of Dental Education of the National Dental Association that are your superiors, and few of them your equals. There are none in the Council on Education of the American Medical Association that are your superiors. They have done it. When you consider that the American Medical Association has continued a man like Arthur Dean Bevan, of Chicago, as the head of their educational council year after year until he was made president of the association, you must realize that they have got somewhere. They have standardized teaching. It seems to me, a body of men like you could organize a council and, if necessary, work in conjunction with the Council of the National Dental Association. They would welcome your assistance in this specialty. If such a council was formed and the results of their work made known, I am sure the boards of education and the state dental boards of the various states would gladly welcome your suggestions and criticisms.

I have wondered if a copy of the nomenclature you adopted last year has been sent to all of the members of the dental educational councils of the forty-eight states. Has it? I mean state boards of dental examiners.

Dr. Casto.—It has been published.

Dr. Fisher.—You have a wonderful work, and you men not only will measure up to it, but out of that will accrue what you absolutely need in this country, namely, not one postgraduate school but postgraduate schools that are standardized and receive the approval of this body of men. I thank you.

Dr. Allen H. Suggett.—There is another phase to this question we have to consider in enlarging our curriculum and making it more intensive and extensive, and it goes along the line of what we were talking about last night in democratizing dentistry. We want better education, longer and better training. We are all more or less handicapped by the conditions under which we are working now in the different universities. The academic courses are all free to students who go there. There is no tuition fee exacted except in the medical and dental departments. In mining enginering, in all other professions and arts, in the universities tuition is free to the student, but not in the dental and medical departments. In those departments large fees are exacted. I say large fees, they are large fees for the average dental student for a three or four years' course as it is now, and most of them require a junior certificate before they can enter there. There are six years of college work. We are going as fast as we can in that direction when we consider how far the state has gone in tax-supported help to the student. If we raise the standard so high and make the curriculum so long that it is going to work a hardship to those who have not the financial means, then we should cut down these courses because we are working against the democracy we have been talking about and putting into the conditions today. We will have to work up the other end of the line and better our education of the people under tax support. No matter how poor the boy is, he should be given an opportunity to go ahead. He should be given the privilege to go through the high school, enter the university, and receive six or eight years of training, as a rule, in the course of time. The more help we can render along that line, the more opportunity will present itself for each man to take up the thing he can do best.

Why is it we have so many failures in life? Do I have to be a shoemaker because my father was one before me? If he were a dentist, there is a chance for me to fall into that for financial reasons. Whether I am a chemist or something else, it is financially impossible for me to choose. Then we can enlarge and lengthen the courses so that there is a chance today to do good for the masses at large rather than to put these things into the hands of a favorite few.

Dr. Federspiel spoke of the Marquette University reducing the number of students from three hundred to forty. That is a good thing in one way, but it is a sad reflection on the state in another way. There are many of those men perhaps the ablest of them, who were financially unable to take this course and had to drop out, but others on account of financial reasons kept on. We should strive to do as much good as we possibly can for the masses at large. While you may have high grade students today, that does not mean you have not cut out superior men on account of financial reasons. While we are getting education and a better course of training, which I believe we all advocate and endorse, let us not lose the social point of view.

Dr. G. W. Grieve.—I was one of those who requested a paper along these lines, because I have been up against the problem of trying to teach orthodontia in a dental school. I have felt for a long time that this society should do something along the lines clearly outlined by Doctor Waldron, or there should be appointed a committee which would eventually produce something we could work upon. It is the dream of all of us, and we shall have to come to it gradually, step by step, and be entirely familiar with it. It is coming, and we should do all we can to advance the science of orthodontia, so that the next generation may have the privilege of living in a period when many of these things we do not enjoy now will be possible.

At the present time, with the facilities we have, and the length of the course in the dental schools, we should strive to establish some kind of maximum course in orthodontia for men taking the general course, the standard of which would be much below that practiced by the men who are specializing. I think this should be undertaken by means of a council as that suggested by Doctor Fisher, establish a course which should be adequately taught and could be more or less absorbed by the students in dentistry.

If I understand the paper of the essayist correctly, he outlined a course which takes into consideration the technic of the work of making appliances on models, even using Doctor Angle's pin and tube appliance, the removable lingual and labial arches of Doctor Lourie with the finger springs, and all the appliances which we are now using as specialists. I think it is a mistake to attempt to teach such things, for those of us who have taught in dental schools know it is a hopeless task. The men going out into general practice, lots of them into country districts, can not refer their cases to specialists, and these men ought to have some knowledge of the subject. There is an old saying, "A little knowledge is a dangerous thing." If we can so formulate a course and dictate to the dental boards and the faculties of dental colleges how far the course should extend, I think then we shall be working along the right lines with the faculties which we have at present for teaching orthodontia in dental schools. You all know it is impossible in a dental school for students to gain a knowledge that men can possess after a number of years in practice as specialists, so to expect them to use Doctor Angle's tube and pin appliances and correct difficult cases is out of the question. If we can formulate an idea of how much these men might be able to absorb, and how much we might teach them, the knowledge of which would be useful, but not dangerous, it would be a splendid thing. The great difficulty I find is to be able to know where to draw the line. It may be possible to draw the line where those men in general practice may be able to treat patients with of underdevelopment and thereby prevent lots of the more difficult and intricate cases of malocclusion. It seems to me we want to work along these lines, and I agree with Doctor Fisher that this society and its members have not done their duty in this matter. Many of the members of state boards and faculties of dental colleges have not the knowledge of men of many years of experience in orthodontia, and yet they are expecting us to do things in the teaching of orthodontia in dental schools which are absolutely impossible. Why not tell them it is impossible, and that it can not be done?

I think you will all agree with me in regard to teaching orthodontia in a dental school, in this respect, that with the limited amount of time the students have and the multiplicity of duties covering the whole practice of dentistry, it is absolutely impossible to accomplish very much. Let us try to make up our minds how much they really can absorb, and then formulate a course as nearly as possible which will conform to that possibility, and in that way get a start. We can not start at the top as Doctor Suggett has suggested, but we can work towards that end. Let us try and get where we can teach them something, but not attempt what is absolutely impossible for them to absorb.

Another great difficulty is the fact that we can not recommend an existing textbook on orthodontia in a dental school. There is no one book that covers the requirements; they all give the student too much. A textbook might be formulated covering the courses especially adapted to those men. Students in dentistry might be shown slides of cases that have been treated by the skilled orthodontist, but they should not be led to believe in the possibility of their treating those difficult cases unless they discontinue the general practice altogether and fit themselves as specialists in orthodontia.

Dr. U. B. Shantz.—I have never been a teacher in a dental college, nor a specialist in orthodontia, although the subject has appealed to me as being of much interest. I have gone through one or two colleges, and I am at this time confronted with the idea that sometime in the future I shall contribute a student to one of the dental colleges, provided my only child shows any degree of fitness for it, and the question arises, since

I have got rid of focal infection and rheumatism, and other things, will it be general practice or will it be a specialty, root canal treatment, the specialty of orthodontia, or what will it be? And the question has arisen in my mind, if it shall be orthodontia that my child shall take up, why should she spend the bulk of her college time on crown and bridge work, on operative dentistry or plate work?

I have been in Doctor Grieve's office, who has spoken. He has not enough equipment in his office to make a plate, because he is doing orthodontic work exclusively. The last time I was in his office I saw a young man who graduated this year in dentistry. He has learned to put in gold fillings, but I am told he has not been able to learn orthodontia in a short length of time. Now, would it not be better to have a selected course for such a man and get him into a place where he can do orthodontic work early in the course even if it would compel him to stay in the city for twelve months in the year. Most of these chaps would rather live in the city than in the country and spend three years on a course if they are going to practice orthodontia, and give them as little general dentistry as they need to know orthodontia. In other words, to parallel if possible the thing that happened sixty or seventy-five years ago perhaps when the dental profession was founded out of a part of the medical profession, and at this time the profession of orthodontia should have a separate college or separate course, gaining only sufficient knowledge of general dentistry as the practitioner may need, the same as we today are gaining only sufficient knowledge of general medicine as we may need, not as much as we would like to have, but as much as we absolutely have to have. This question appeals to me, and I wonder whether that will be a solution or not. I do not know. I wish I did.

If the idea I have advanced will furnish food for thought to some of you who may be on the council to be organized, I am glad that I have contributed it because it is a phase of the subject that was not mentioned in the discussion.

Dr. F. M. Casto.—There was one matter mentioned which I think is of very great importance, and it has been suggested that we might have closer association between the American Educational Council and the council from this association or any other association of dental colleges and state boards. The dental colleges, as I said a few moments ago, are under the supervision of the War Department at the present time, therefore the requirements have to be lived up to. Standards are being established all over the country so that a dental student admitted in New York or California, or in the North or in the South will have practically the same education. No standardization has ever been made of state boards. The standardization of state boards is the standard of each state or the standard of each board. The government at the present time has no supervision over the state board of dental examiners, so that there is no coordination between dental teaching and state board examinations in many of the states. There is no coordination between the teaching in dental colleges and state board examinations in many states, and if anything can be done to bring about closer cooperation between these organizations it would only be fair to the man who is to put in his time studying dentistry.

Dr. Burt Abell.—Why would it not be a good idea for this board of control of the government to send out the examinations, in order that that may be taken out of the hands of the state boards?

Dr. Casto.—It can not be done now on account of the state laws.

Dr. Fisher.—This regulation that Doctor Casto refers to will end with the war. The only thing we can hope for in this respect is to form some character of organization, such as a national organization of your dental examining boards just as some of the colleges have throughout the country. I mean a real one, and I do not mean the way it has been run.

Dr. Casto.—We have to have standardization throughout the country so that there will be coordination between the two.

Dr. Allen H. Suggett.—A state board of examiners is superfluous. I believe it is only a matter of time when the government will control the different colleges, so that when a man graduates from any college he can practice in any state. At the present time, some of the states have a higher standard than others, hence it is more difficult to pass the state board in some states than it is in others, but I believe in the course of time this will be eliminated or rectified.

Dr. Waldron.—I am pleased that my paper has brought out such a free discussion, for that is why the paper was written, in order that we may standardize the teaching of orthodontia in our colleges, but I am sorry no suggestions have been offered wherein some beneficial changes may be made.

It has been pointed out by Doctor Mershon that we have to prepare students for the state board examination, as well as to give them a dental education, and he has truly remarked that many of the questions asked by members of these boards are very ancient. Therefore we must instruct students in these antiquities in order that they may give satisfactory answers to men whose ambition it is to be members of these boards, regardless of their qualifications.

Luckily for all concerned these men are in the small minority, and I hope the day is not far distant when there will be a standardization of state boards as well as dental colleges.

I think that Doctor Grieve has not understood that part of my paper regarding the technic work in the junior year. We have devised a manikin head at the New York College of Dentistry and the student is obliged to construct the technic work upon models in the manikin head, which I think is about the nearest thing to working on the living subject.

This is merely the construction of appliances and their application on technic models, in order to prepare the student, that he may be more able to work on the human being in his senior year.

It would be a mistake to give a student material and allow him to work upon a patient before he has had practice upon some inanimate object.

The idea of this technic work is not to impress upon the student that we recommend these kinds of appliances, but that he may have a variety of technic work, in order to better fit him for the construction of such appliances that are to be used on living subjects in the senior year and later in his own practice.

DENTAL ENGINEERING: WE ASSUME—WE CONCLUDE

By Rudolph L. Hanau, Pittsburgh, Pa.
Consulting Dental Engineer

WE take it for granted that the author of "Determining the Shape of the Normal Arch" (*Dental Cosmos,* July, 1917) is perfectly honest in his intent, yet we are constrained to observe that a comprehensive knowledge of dental engineering would have led him through a different lane of investigation,—one that does not lead to misconception of the problem and to vague conclusions.

A thorough understanding of dental engineering would have rendered the investigator self-supporting and could have precluded the possibility of leaning too heavily upon the preliminary findings or conclusions of experimentors, and of the inclination of quoting the mere opinions of Drs. Y or Z who see through a species of self-hypnosis, things from a point of view to suit their opinions, with the result that they offer in evidence opinions only—but no proofs. We shall prove that the conclusions at which Dr. P. N. W. has arrived are not only vague, but erroneous.

He concludes: "The shape and size of the mouth are determined by the underlying structures, chiefly the six anterior teeth." That is just as true as it is untrue. The establishment or affirmation of this hypothesis is no stronger than its negation.

A lot does not determine the building we erect thereon. The kind, the quality, and the distribution of the building material, the architect, etc., are factors in the equation of the ultimate results; and we must not forget the purpose for which the building is intended.

"The underlying structure," assuredly, has some relation to the mouth, as it has, also, to the distribution of the teeth: and so too, has the lot to the building.

The protruding and retruding jaws give us conclusive proof. Between the jaws and the teeth and the tongue, etc., there exists a very complex coordination. The relationship will be perfect, if the denture has fulfilled all the requirements which nature has prescribed. It is subject to doubt that a perfect denture has ever been discovered and discerned as such.

On the other hand it may be possible to find six near perfect dentures of six quite different types, or races as the case may be; let us say; Negro, Mongolian, Indian, Aryan, Semite, American, the last mentioned having been discovered, evidently, by the author of "Determining the Shape of the Normal Arch," and his handicapped professional precursors.

It is to be expected that the underlying structures of the six enumerated "types" vary greatly, *i. e.,* that the distribution of bone and other tissue differ considerably—and so also the formation of the mouth in general.

If we take these six hypothetical cases for our investigation, and measure the tooth material and different chords of the arch, we may find the arches

alike (or geometrically similar) and the tooth material different (or not proportional) or the tooth material the same (or proportional) and different arch form (not geometrically similar) or different tooth material and different arch form.

If we were of the old school we would no doubt be able to prove that the arch form changes with the race of man, because after being lucky enough to have discovered six near perfect dentures we expect more—to have discovered six dentures, typical of the race to which they belong.

We do not hesitate in assuring our contemporaries that dental engineering can provide an analysis convincing, conclusive and absolute—of all six cases.

We may venture to say that distorted arch forms frequently occur though the jaws be fundamentally normal, and that immediate underlying structures may be severely disturbed by the very teeth, whose positioning these underlying structures are, supposedly, to direct, which process may be accounted as one of natural reaction.

Such cases of malocclusion yield easily to treatment. They are the pièces de résistance" in the orthodontist's model case, and very often, be it stated, he does not know the exact reason of his accomplished success.

The six anterior teeth, as an individual group, have a very small share in determining the arch form. Their relation to the lower anterior group is a determining factor in generating the anterior curvature. And this very relation is a capital function.

Some of the reciprocal factors which participate in the molding of the dental arch form are: Labio-lingual distance of the C.C.C.'s at the median line, and the bucco-lingual distance of the C.C.C.'s at the cuspids, the tongue and the lip pressure, the underlying structures, the condyle path, the food we masticate, habits of living. There are others.

To assume the ratio 14:9 to be the distinct American type is very farfetched, and risky inasmuch as the ratio 14:9 is the mean average of, probably, all upper arch forms, of the species *homo sapiens.*

We have no absolute proof but, if the *belief* of the author of "Determining the Shape of the Normal Arch Form" is correct, it must be so.

He quotes:

"There is no anatomical part in mammals so uniform as dentition. Even between primitives and man there is a striking likeness of the shape of the jaw. Teeth make the arch, and the species' variability is so small in a racial type that it requires careful measuring to detect the difference in shape."

The quotient "9" in the

ratio $\frac{14}{9}$

decreases, (for a given tooth material), and a constant first molar buccal groove distance, with the decreasing

ratio $\frac{T_{l_i}}{T_{u_i}} = \frac{\text{Lower incisal tooth material}}{\text{Upper incisal tooth material}}$

The quotient "9" also decreases with the decrease of the overbite and in-

creases the more the tooth axes of the incisors approach the vertical to the lateral plane, etc.

The 14:9 ratio as a working basis is open to serious objections.

In the hands of most practitioners it is a dangerous toy,—just as mischievous and dangerous as any other arbitrary arch form; as for instance, the mechanical determination of the arch form which has been brought into the foreground lately, and which, instead of producing *the* arch form, is nothing but an arbitrary method of generating *an* arch form.

The arbitrary arch form and the arbitrary arch form determination, are very useful, theoretically, in the dental school, but neither can be considered worthy of direct application in the practitioner's office.

Dental engineering has proved that the employment of empiricism is not consistent and conscientious, scientific practice, and that certain arbitrary methods, while they may add to the comfort and the coffers of the happy-go-lucky practitioner who does not see his mission, or seeing it, buries his head —ostrich like—in the sands of complacency, must eventually prove a boomerang to the profession.

Let us assume, the mean average ratio, were

$$\frac{A}{B} = \frac{14}{9.}$$

This would be very interesting, though not important. It certainly is of no value to the orthodontist, unless he is anxious to build up a preliminary arch form, to be used as a step toward the better arch form.

He may so proceed, but safely only if he understands dental engineering.

Let it be noted that for the purpose of constructing a preliminary arch form, if that were advisable, it is not necessary to *carefully maintain a given ratio in order to obtain a normally shaped arch.* It is well to be careful. We do not yet have such a thing as a normally shaped arch, identified as such, and it may forever remain the Messiah of the realm of arch forms.

The dogmatic ratio, $\frac{14}{9}$, is erroneous; more so the ratio

$$A : B : C : = 14 : 10 : 9.$$

Were the latter correct, then it may be arbitrarily extended on its own merits to:

$$A : B : C : D : E : F : G : = 14 : 10 : 9 : 7.07 : X : Y.$$

where X = factor for the incisal radius,
Y = factor for the tooth material.

The reader is referred to Fig. A.

But fixed relative values of a few of these factors would result in the necessity of various types of arch forms, geometrically similar. Diligent research will enable us to find arch forms which can be classified within certain geometrical figures, but we shall find all races more or less represented in all classes. Consistent research will be certain to definitely determine that the distinct American type which the author of the article referred to imagined he had discovered does not exist, and we prognosticate that such "distinct Ameri-

can type" will be found to be distributed *with* the "types" of western and central European races, amongst the arch forms of man, classified according to their geometrical forms.

He concludes:

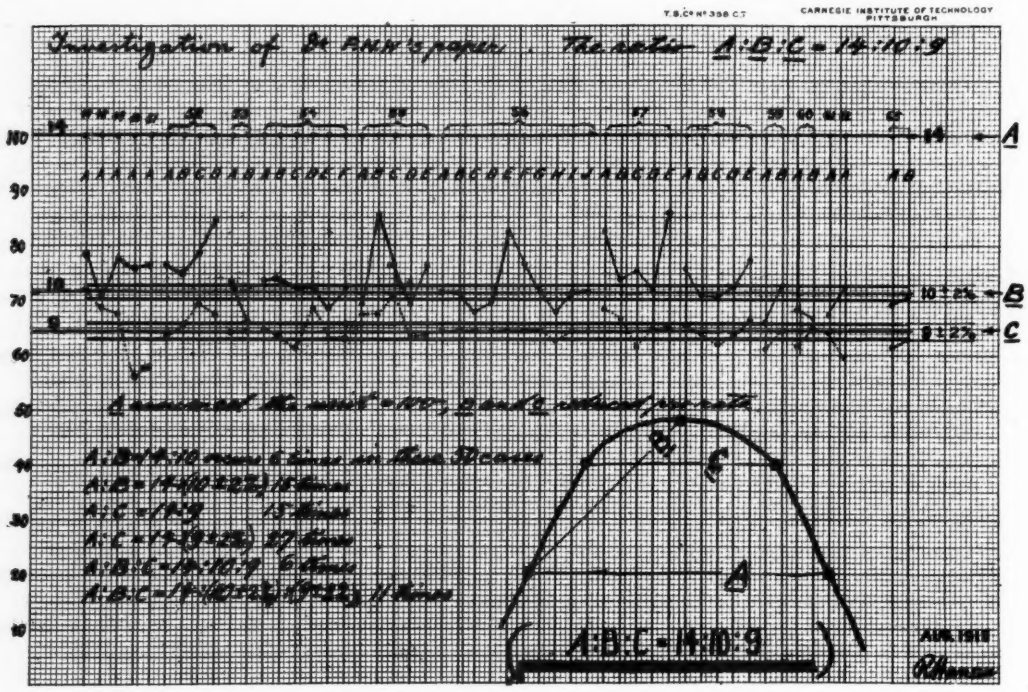

Chart I.

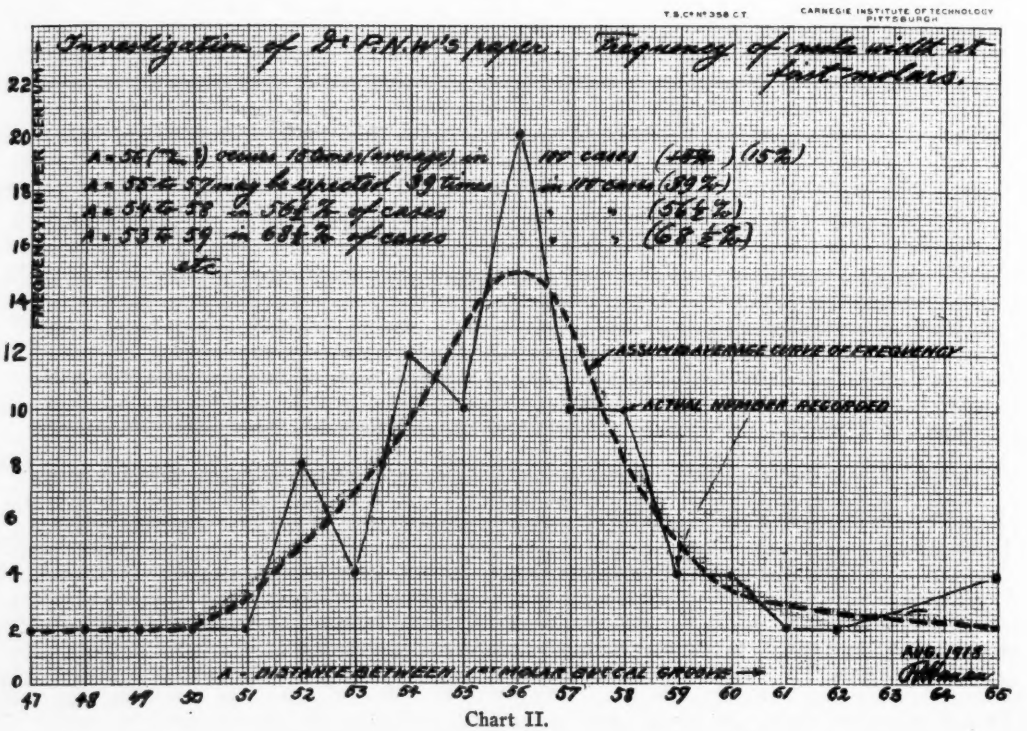
CARNEGIE INSTITUTE OF TECHNOLOGY
PITTSBURGH
Investigation of Dr P.N.W's paper. Frequency of male width at first molars.
FREQUENCY IN PER CENTUM
ASSUMED AVERAGE CURVE OF FREQUENCY
ACTUAL NUMBERS RECORDED
A - DISTANCE BETWEEN 1ST MOLAR GUTTA CALS
AUG. 1913

Chart II.

Many arches are badly deformed, because of lack of knowldege "of fundamentals and correct technic."

He is right.

"Arches that are not natural in shape can never be retained." That means nothing; because we do not know what is "natural in shape."

Let us assume we have an arch: the upper laterals are extracted, or that there is a supernumerary lower incisor. Can such arch form never be retained? Or, if it be retained, is the arch form natural in shape?

Charts I and II are plotted from the table of measurements which Dr. P. N. W. gives in his own paper. His own designations A. B. and C. are adhered to.

In Chart I the arches are arranged in groups according to the distance A. The values B. and C. are reduced to A=100, and entered accordingly. The conclusions are added in writing.

The Chart II, if extended over a great number of cases, may lead to some

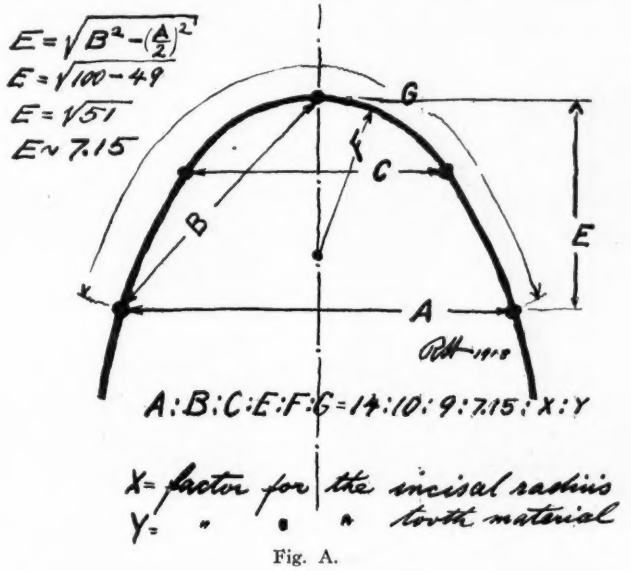

Fig. A.

interesting findings: the frequency with which a width of arches at the first molar buccal grooves occurs also, at its maximum, its minimum, and its "normal" width. By the latter we do not mean the mean average, but, rather, the most frequent widths. The latter is of more interest to the anthropologists, than of importance to the orthodontist.

We assumed that the measurement tabulated by Dr. P. N. W. are correct, yet we must conclude that his findings are *erroneous.* There seems to exist, in the minds of a few, the opinion that engineering and esthetics could not, very well, be combined. Engineering has passed that embryonic period decades ago.

As a dental engineer I wish to show that neither scientifically nor philosophically am I opposed to nature and beauty, by freely acknowledging my admiration for the good taste Dr. P. N. W. exhibits between the lines 8 and 9, column 2, page 488, volume LX of the *Dental Cosmos.*

HOW FAR CAN A TOOTH BE MOVED WITHOUT DESTROYING THE PULP?*

By F. C. Rodgers, D.D.S., St. Louis, Mo.

Professor of Orthodontia, St. Louis University Dental School.

DURING the course of treatment of orthodontic cases, teeth often have to be moved bodily to varying distances in order to bring them into normal occlusion. The question has often occurred to me, "How far can a tooth be moved without destroying the vitality of the pulp?" Recently, a case was presented to me for treatment which offered an opportunity to answer this question.

The patient was a young miss of fourteen years, with all the permanent teeth erupted in normal occlusion except the upper left cuspid which was impacted over the buccal roots of the upper first molar and lying diagonally across these roots. The tip of the cuspid crown erupted just through the gum to the mesial

Fig. 1.—Note tip of cuspid protruding through the gum above the second bicuspid; outline of root indicated by pencil mark on model.

Fig. 2.—Occlusal view, cuspid moved mesially, crown portion fully exposed.

of the buccal cusp of the molar and the apex of the cuspid superimposed over the distal root of the molar. (See Fig. 1)

The problem presented for solution was, to move the cuspid bodily from this impacted location past the two bicuspids into its normal position. The case was further complicated by the location of the tooth which made it impossible to attach an appliance. (See Fig. 1.) The survey made on the model shows the distance that the apex of the cuspid had to be moved. (See Fig. 4.)

TREATMENT

The first stage of the treatment was started with a Jackson removable appliance, consisting of a delicate spring wire curved up over the gum, distal to the second molar and made to bring pressure mesially against the cuspid root

*The models were exhibited at the Clinic of the American Orthodontists' Society Meeting, Edgewater Beach Hotel, Chicago, August 1, 2, and 3, 1918.

at the junction of the crown. Active force for moving the tooth was obtained by repeatedly opening the loop of the spring wire until the tooth was in a position as shown in Fig. 2.

At this stage, the position of the tooth began to change from vertical to horizontal, as shown in Fig. 3, which necessitated the use of a different appliance. A band with a root-wise extension (Case) was adjusted and cemented on the crown. An alignment wire anchored on the molar teeth was used to hold the cuspid crown in position, while moving the root mesially by means of sea-grass ligatures which were attached to the root extension on the band to a spur opposite the central on the alignment wire.

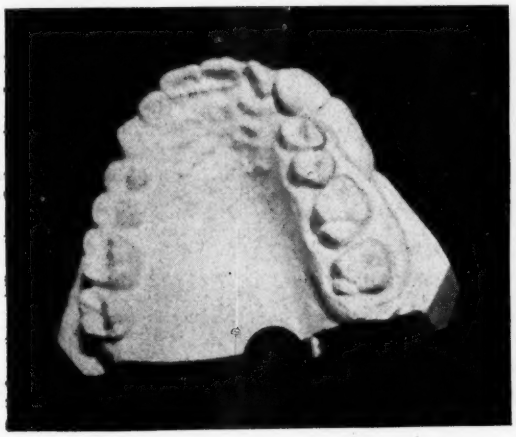

Fig. 3.—Buccal view, root plainly outlined on the gum in a horizontal position. Tooth very loose.

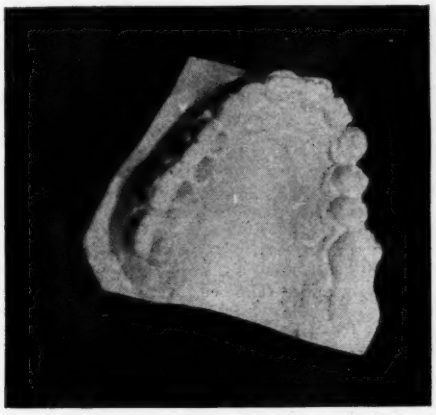

Fig. 5.—Occlusal view, same case, also showing retaining appliance on the lingual.

Fig. 4.—Buccal view, showing cuspid tooth in normal position. Survey shows distance tooth was moved ($1\frac{1}{16}$ inch).

The stability of the tooth at this stage was in a precarious condition; it was held in place by a thin layer of gum tissue over the root; the apex was almost exposed, while the crown had to be supported and held in position by the alignment wire. The vitality of the pulp, up to this stage, was normal; it responded to thermal tests.

Figs. 4 and 5 show models of the case with the cuspid tooth in its normal position. Further treatment was suspended on account of the summer vacation and in order to give nature a chance to stabilize the tooth by regeneration of peridental fibers and a deposition of the bone around the root. Fig. 4 is a model showing the case at the present time.

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EDITORIALS

The Removable Lingual Wire With Finger Springs

IN the April, 1917, issue of the JOURNAL we published an article on "The Band and Lingual Arch Technic," by Dr. John V. Mershon, of Philadelphia, Pa. The article at that time was revolutionary to a large number of men who were unfamiliar with the lingual wire as described. It was only after considerable persuasion that we succeeded in getting the article from Mershon at that time, but having seen his work, we were convinced that the lingual wire as he uses it possesses possibilities equaled by but few appliances. Until the publication of the lingual wire as used by Lourie, in conjunction with the wire-stretching pliers, and the removable lingual wire as used by Mershon, most of the orthodontic results were being obtained by the labial wire. It is true Jackson had for a number of years used the removable appliance known as the "Jackson appliance" which possessed a great many

advantages, and which has not received the recognition it should have had as a basic principle in orthodontic treatment.

In this issue, we publish a paper by Mershon, read before the American Society of Orthodontists, which shows a broader technic in the use of the lingual wire and especially calls attention to the use of the auxiliary springs which greatly increase the range of usefulness of the lingual alignment wires. We believe there is no appliance which will produce tooth movement as easy and with as little inconvenience to the patient as the properly constructed lingual alignment wire with the correct auxiliary springs. The greatest difficulty in the use of the removable lingual alignment wire is that of anchorage and the greatest trouble that will be encountered will be in the displacement of the anchor teeth resulting from the operator putting too much stress on the malposed teeth at one time. We have seen several cases where men attempted to use the removable lingual alignment wire and failed to realize, owing to the delicate nature of the force, that the anchorage was just as important as it was in the use of a heavier appliance. Owing to the fact that the lingual alignment wire is smaller than formerly used in the labial wire, improperly fitted appliances can be forced into the tube on the molar band without any perceptible pain to the patient, and the slightest amount of spring in the alignment wires when placed in the molar tube will eventually move the anchor tooth. Disastrous results also occur in the cases where operators allow too long a time to elapse before seeing the patient. Mershon recommends four or eight weeks between visits, which is perfectly safe and feasible, if the appliances are so adjusted as to be working exactly right. However, in the hands of the inexperienced and of those who have not used the removable lingual alignment wire in many cases, we would not recommend as long a period between visits, for in many cases an undesirable force will be present on some of the teeth, and before the patient returns a large amount of undesirable movement would be produced.

The greatest difficulty in the use of the lingual alignment wire is that of anchorage and every care must be observed in conserving the anchorage if we are to obtain the best results from the removable lingual alignment wire with spring attachments. One advantage of the spring attachments is that the force can be exerted upon the malposed tooth or teeth without greatly changing the other teeth or the forces upon the approximating teeth. In order to make the individual adjustment of the malposed teeth or roots possible it necessarily follows that the anchorage must be secure and that there must be a considerable difference in size between the main alignment wire and auxiliary spring so that when force is exerted by the spring, the removable lingual alignment wire will be heavy enough and strong enough to absorb the force without any resulting displacement of other teeth. It is needless to mention that inconspicuousness of the lingual alignment wire is so satisfactory to the patients that they will wear these styles of appliances when they would not wear the old styles or newer forms of labial wires. We do not believe that anything from the standpoint of a mechanical appliance has been given to ortho-

dontia for the past ten years that offers so many advantages as the lingual wire whether used in a removable or the soldered form and believe that those interested in the practice of orthodontia can do nothing which will be so valuable to themselves and their patient as to master the technic of the use of the lingual wire.

The American Red Cross Home Service

THE time will come after the disabled soldier or sailor has received the benefits of the Government's medical and surgical care and vocational training when he will go to work at his old occupation or in a new position which the Government has found for him. Our country will have done everything possible to restore to each man what has been taken and used in the national service. From this time the Red Cross and other community agencies will gradually take over the chief responsibility for such further assistance as the man may need. The rest depends upon the individual and his personal will-power and capacity for recuperation.

For many returned men who will supplement their innate resourcefulness with these advantages, no further assistance will be needed. Others, less forceful and self-reliant, or more seriously handicapped and disheartened, will require some degree of friendly sympathetic oversight and encouragement to carry them through the first critical months until they have found themselves in their new work. This is no work for a distant and impersonal official agency. Rather it is a task for personal friends close at hand and intimately aware of the man's everyday problems and difficulties. This is appropriate work for the Red Cross. It is especially appropriate work for the Home Service Section which in many instances has already had the privilege of helping to maintain intact the standards of health, education, and home life of the soldier's family during his absence.

The Red Cross is strategically well-equipped to undertake the follow-up care of returned soldiers. Each soldier discharged on account of disease or wounds will return to a community where the Red Cross will already have served his family, if there has been any kind of need.

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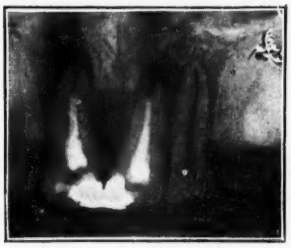

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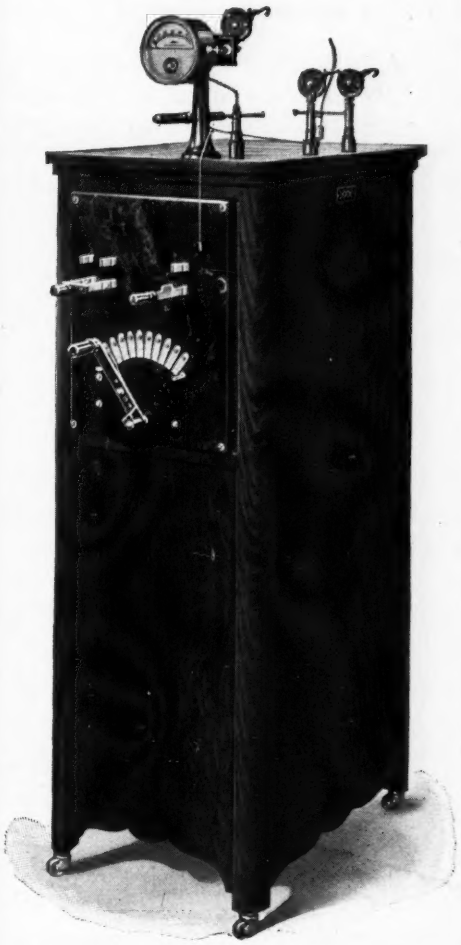

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